

TEAM INTELLIGENCE: THE FOUNDATIONS OF INTELLIGENT ORGANIZATIONS

- *A Literature Review*

Philip Runsten



ACKNOWLEDGEMENTS

This report was funded by Vinnova and Influence AB. I wish to express my gratitude to the following persons for their contributions in the making of this report. Firstly, my professor and co-author in previous publications, Prof. Andreas Werr, who has been vital in all aspects of this report. Secondly, Jan Sandred at Vinnova, for his availability, flexibility, and support in making this report possible. Finally, I thank the management team of Influence in general and our managing director Johan Wieslander in particular for their never-failing support and trust in the importance of developing our knowledge on collective intelligence.

Stockholm, 22 February, 2017

Philip Runsten

This report is published in the SSE Working Paper Series in Business Administration as No 2017:X,
February, 2017, to make it accessible to the research community.

Version 1.0.

TABLE OF CONTENT

Introduction.....	5
Some theoretical background about teamwork.....	6
Collective intelligence at group level.....	8
Collection of data and sources	9
What is intelligence?	10
What is collective intelligence?	11
The difference between collective intelligence and team intelligence	13
Development of observable and measurable collective intelligence.....	15
A definition of group level collective intelligence	16
Collective intelligence in organizations.....	19
Human organizations are complex adaptive systems.....	20
Structure becoming function through coordination	21
Systems as collective mind	22
Organizations as hierarchies of isomorphic systems.....	23
Micro-systems as nodes of coordination in organizations	25
Summary of perspectives on collective intelligence in organizations	25
Structuring and analyzing the literature	27
1. Learning as a result of group patterns.....	29
Psychological factors in group learning.....	31
Cognitive factors and group learning.....	33
Process and organizational factors in relation to group learning.....	35
Stimulating learning processes at group level.....	39
2. Factors for individual learning in groups.....	45
Psychological and cognitive factors related to individual learning	45
Process and organizational factors in individual learning	47
Stimulating learning on individual level.....	49
3. Knowledge systems as group patterns	52
Collective intelligence—a process of self-organization.....	52
Cognitive and psychological factors in knowledge systems	53
Process and organizational factors in knowledge systems.....	58
Stimulating groups to enact intelligent systems	61
Individuals coordinating intelligent systems.....	69

Heedful interrelating	69
Psychological factors in individual coordination.....	71
Cognitive factors in individual coordination.....	74
Process and organizational factors	75
Stimulation of individual coordination.....	79
Knowledge gaps and need of future research.....	91
Research on discretionary behavior	91
Agreeing on a measure—the c-factor?.....	92
Practical implications.....	93
The intelligence society.....	93
The language of cooperation	95
Short-circuiting management and employees.....	95
Add rather than replace.....	96
References.....	97
Appendices.....	110
About the author.....	112

INTRODUCTION

The underlying forces behind what we claim is an increasing interest in collective intelligence are specialization and knowledge distribution. As society becomes ever more specialized and knowledge distributed it also becomes more complex, and we become increasingly dependent on how to integrate all this knowledge (Tsoukas, 1996; Grant, 1996). This is what is behind the knowledge economy and the increased importance of intangibles such as knowledge and intellectual resources, the need for innovation, and the means to realize intellectual capabilities. As a result, organizational effectiveness and innovation have become more dependent of what has been called *knowledge management*. In early studies of this development, the issues of knowledge management were largely identified as how to capture and redistribute knowledge with the help of new information technology. Following that, focus turned to other aspects of managing organizational knowledge, such as processes, special forums, training programs, mentoring, and so forth, but still with the tools and thinking of the industrial society (see Furusten & Werr, 2012, for a recent overview). Most of the research on knowledge management, however, avoided addressing a central phenomenon in knowledge integration and organizational coordination, namely the professional work groups and micro-systems¹ (Gardner, Gino, & Staats, 2012). Studies show that the proportion of coordination in

organizations, in the form of more or less independent work groups, increases in general and especially in so-called cross-functional teams² (Benders et al., 2001; Pearce & Conger, 2003; Salas et al., 2008; Klein et al., 2009, DeChurch & Mesemer-Magnus, 2010; Cross, Rebele, & Grant, 2016). Both governmental agencies and private industry are increasingly relying upon work teams as a preferred performance arrangement to fulfill their visions, execute their complex missions, and accomplish their goals (Salas et al., 2008). Sweden, may in this respect, be one of the countries where development has progressed the furthest.

The underlying change driving the increase in the use of groups and teams for coordination is, of course the increasing number of specialists needing to come together and coordinate. This, in turn, drives complexity, and the only way for organizations to deal with complexity in the long run is by intelligence; intelligent coordination. As this report will show, some of the most important means of realizing organizational intelligence will be the cognitive, social and emotional capabilities of teams. Integrating knowledge between individuals, at group level, is not merely a matter of connecting different forms of information sources. Instead, attention needs to focus on the quality aspects by which knowledge can be integrated and coordinated, what we here will call *collective intelligence*. Despite a vast literature on teamwork and group effectiveness, present theory speaks very little about the cognitive and emotional

¹ Micro-systems can be described as collaboration, at a specific time, between a given set of individuals. These micro-systems are sometimes identifiable groups, such as management-teams, but often occur in more temporary constellations, such as a temporary coordination meeting or spontaneous meetings of coordination between colleagues. They are occasions where individuals, as knowledge carriers, must integrate their knowledge for

an organizational purpose, either within or between organizations.

² A group created to bring together different functional competencies and specialists for collaboration or innovation.

dimensions of teamwork, yet those are exactly what will become the cornerstones of performance in the changing economy (Goyal & Akhilesh, 2007). There is ample support in the literature for the contention that team-based forms of organizing are beneficial both to organizations and to individuals. Team-based work leads to improvements in organizational performance on measures of both efficiency and quality (Klein et al, 2009). However, the simple existence of a team-based organizing structure is not enough to ensure that positive outcomes will result. Teams must be nurtured, supported, and developed, or else they may actually be a worse alternative to individuals working alone (Lyubovnikova et al, 2015).

In the end, today's organizations are populated with an increasing number of work teams, because of increasing specialization of knowledge. Motivated and successful teams, coordinating this knowledge, are becoming the key to successful organizations, but knowledge integration in work teams continues to be a prominent issue in most organizations. Our hope is that this report will contribute to our understanding of these phenomena and the development of organizational strategies for collective intelligence.

SOME THEORETICAL BACKGROUND ABOUT TEAMWORK

Due to our long history of interest in the theory of groups, there is much literature available about the functioning of groups. Existing theory describes well various aspects of group development (e.g., the stages of group development such as forming, storming, norming, performing and adjourning), as well as group dynamics, describing various group-generic competencies such as collaboration, conflict resolution, norms and standards, communication, goal-setting, and so forth, and how they are related to each other and group

performance (Goyal & Akhilesh, 2007). Kuipers and Stoker (2009) describe various schools of thought that deal with the issues of how groups develop. These are divided into three main types:

1. *Phase models* (including group dynamics, consultancy, and sociotechnical phase models): The most commonly used and cited approach in the group-dynamics literature is the group development theory by Tuckman (1965). This theory describes five phases through which a group passes: Forming, storming, norming, performing and adjourning
2. *Recurring phase models*: Criticisms of phase model theories led to the development of another perspective on teamwork phases which sees the development process of a team as much more complex than sequential phases. Gersick (1988; 1989) introduced the idea of two main phases—her punctuated equilibrium model—in which an initial phase, half way through the group's lifespan, undergoes a transition into a certain action phase.
3. *Process models*: Another, more process-oriented, theory linking teamwork to performance is Gladstein's concept of group processes (1984). In her study of 100 small sales teams (two-four people), she showed that the group processes were clearly divisible into an intra-group process and a boundary management process. The first included aspects such as open communication, supportiveness, conflict management, and discussion of strategies. She defined boundary management as the “degree of misunderstanding with external groups.” A feature of Gladstein's theory is that it sets out to describe the processes occurring within teams without trying to order what comes first and what comes last. She also considers the intra-group processes and boundary management to be parallel processes.

Based on their extensive review of team development literature, Kuipers & Stoker propose to develop this perspective. Instead of linear phases, they describe team development and the building of a representation in a work group as three general team processes:

- internal relations—goal orientation, planning activities, feedback, conflict management;
- task management—multi-functionality (the team members often interchange tasks), delegated management and support tasks, work communication (the team members share information about the work), decision-making and control (the team divides the tasks), performance management (the team acts on mistakes); and
- external relations and improvement: Improvement activities (the team members often take initiatives for improvement), external relations, (the team solves problems with their related parties), advanced management and support activities, (the team arranges back-up and support when necessary).

In addition to group development, many other aspects of group dynamics and group-generic competencies have also been extensively studied. Here follow some examples compiled by Goyal & Akhilesh (2007):

- the impact of task type and group size upon individual and group performance, studied by Steiner (1966, 1972, 1974) and by Hackman (1976, 1977);
- the relevance of group member characteristics (Hoffman & Maier, 1961);
- research on group interaction, group processes in terms acts and participants (Bales,

1950, 1953; Bales and Slater, 1955; Bales and Strodtbeck, 1951);

- the nature and impact of group needs, group member motivation and coordination (Steiner, 1972; Hackman and Morris, 1975; Hare, 1973, 1976);
- task- and team-generic competencies such as: conflict resolution, collaborative problem-solving, communication, goal-setting and performance management, planning and task coordination (Cannon-Bowers et al., 1995; Stevens and Campion, 1994; Swezey and Salas, 1992);
- group personality, intelligence, emotional intelligence (Halfhill et al., 2005; Williams and Sternberg, 1988; Gant & Agazarian, 2004). At the individual level, for example, social skills have been underlined for effective performance in team settings (Campion et al., 1993; Mohrman and Cohen, 1995).

Although there is extensive theoretical and research output about various characteristics of group and teams, agreement has not been reached on more comprehensive and generic factors, or abilities, which could underlie the development of structure and function of groups. Attention has been directed primarily toward understanding tasks rather than emotional elements (Kelly & Barsade, 2001). However, interest in studying affective (emotional), cognitive and behavioral mediational processes has increased, but the efforts have been fragmented and non-cumulative, partly due to a lack of generally accepted and distinct constructs. Also, when it comes to measurements, which is one of the essential prerequisites for dependable research output, existing literature has very little to offer. Goyal & Akhilesh therefore calls for a need to research and develop the conceptual tools to capture the phenomena of personality, intelligence, emotions,

learning, and creativity at group level. One of the purposes with this report is therefore to give an overview of these aspects of groups in relation to intelligence.

COLLECTIVE INTELLIGENCE AT GROUP LEVEL

Studies of micro-systems, either in the form of groups or meetings, shows that the variation in the degree of knowledge integration is high, both from quantitative and qualitative perspectives (Wheelan, 2005; Losada & Heaphy, 2004; Edmondson, 1999; Rico et al., 2008; Runsten, 2011; Werr & Runsten, 2013). Lately, these variations in the quality of micro-systems have started to be termed collective intelligence (see below under *What is collective intelligence?*). Studies of groups performing different forms of cognitive tests have verified that groups do develop some form of measurable and variable intelligence, called c-factor, in a similar way that individuals do, the g-factor (Woolley et al., 2010). Since the development of the g-factor as a measure of individual intelligence, it has been widely recognized as a major factor accounting for performance in various domains. There is no reason this should not hold true for groups as well. Individual intelligence has been analyzed in several fields, for example, psychology, neuropsychology, and sociology. Thus, there are various models of human intelligence. Wechsler, for example (1958), defined intelligence as “the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment”. However, group intelligence is a concept distinct from the concept of individual intelligence, and as Szuba (2001) noted, research is comparatively poor when it comes to intelligence of groups. Only a few books can be found on the subject. In the interdependent context of groups, group members may be involved in collaboration differently due to their abilities and desires,

yielding a system with characteristics and capacities unlike those which one group member would display alone. Collective cognition differs from individual cognition because it encompasses a social and a communicative dimension. Thus, group intelligence could be said to be the functional intelligence of a group of people working as a unit (Williams & Sternberg, 1988). Just as an individual's intelligence may be based on many aspects of his or her behavior, so may the functional intelligence of a group consist of many aspects.

Glynn (1996) extended the concept of individual intelligence to organizational intelligence and argued that it is “an organization’s capability to process, interpret, encode, manipulate and access information in a purposeful, goal-directed manner, so it can increase its adaptive potential in the environment in which it operates.” The collective intelligence of an organization would then be embedded in its systems, routines, operating procedures, symbols, culture, and language. It relates to and can increase the intelligence of groups if these systems encode declarative and procedural knowledge that is complex, information-rich, and isomorphic with environmental demands (Glynn, 1996). In addition to organizational intelligence, the collective intelligence of a specific team would then reside in its capacity for information processing with which the group would be able to solve problems, the quality and timing of its decision-making and so forth. In this report, we argue that variations in the capacity for knowledge integration and coordination, at group or micro-system level, could be called one form of collective intelligence. This variation could, in addition to structural conditions, be linked to cognitive, psychosocial, and behavioral factors of knowledge integration and, hence, through the group, such factors could

be related to successful organizational coordination.

When different individuals' knowledge should be integrated for a specific purpose, individual, situational, and social conditions will matter (Carlile, 2004; Schön, 1983, Edmondson, 1999). Depending on experience, professional and organizational background, and so on, different individuals have different representations (mental models) of the situation (Brandon & Hollingshead, 2004; Mohammed & Dumville, 2001; Rico, Sánchez-Manzanares, Gil, & Gibson, 2008). Such differences are central to knowledge integration because they represent potential for new knowledge and innovation (Hargadon, 1998; Hargadon & Bechky, 2006), but they also present challenges in the form of potential misunderstandings and negative conflicts (Edmondson, 1999), knowledge boundaries (Carlile, 2004), focus toward either outcome or process (Woolley, 2009), high or low levels of trust (Langfred, 2004), and defensive behavior (Argyris & Schön, 1978) and so forth. These challenges are particularly evident in so-called knowledge-intensive work, characterized by complexity and ambiguity, and allowing for a wide range of interpretations of both task and goals (Alvesson, 2004).

If we summarize the above, it is here argued that organizations are increasingly becoming dependent on micro-systems for intelligent knowledge integration, and ultimately for their performance, innovation, and renewal. At the same time, research shows that knowledge integration in micro-systems still demonstrates a high degree of variability regarding efficiency and coordination—collective intelligence—and that this variation is dependent on factors that organizations, as of today, have obvious difficulty measuring and controlling. Both to develop and to increase leverage of existing organizational

structures and investments, organizations need to increase the control of such phenomena, which in turn means an increased need for understanding what collective intelligence is and how it's formed. Critical questions would be:

- What are the relationships between individual, micro-system, and organizational intelligence?
- What is intelligence at micro-system level?
- What are the factors that influence intelligence at micro-system level?
- How can these factors, in turn, be influenced, from an organizational perspective?

The following report is a compilation of studies conducted on the phenomena of collective intelligence at the micro-system level and related factors. The purpose of the report is to provide a summary of what these studies show and indicate some answers to the above questions. The first part of the study summarizes the collection of data and the sources used.

COLLECTION OF DATA AND SOURCES

The database *EBSCO/Business Source Premier* was used to search for relevant articles in academic journals. Since *collective intelligence* is a rather new way of coining the phenomena of quality in knowledge integration at group level, the search was extended to include previous headlines of such studies, such as *learning*, *decision-making*, and *problem-solving*. The term *collective intelligence* is also used for other collective phenomena, from insect behavior to Wikipedia. Since this study focuses on group level, the terms *group* and *team* performance were added. The term *performance* was added to find articles that discuss the quality of collective intelligence in relation to the purpose of the group or team.

EBSCO/Business Source Premier, search criteria:
Full text, Peer reviewed, Academic journals,
Article:

- Collective intelligence
- Group/team intelligence
- Group/team decision-making + group/team performance
- Group/team problem solving + group/team performance
- Group/team learning + group/team performance

A total of 92 articles and two dissertations were selected based on the search. In addition, literature previously identified as relevant from the list of references in the dissertation *Collective Ability* (*Kollektiv förmåga*, Runsten, 2011), were added. The search of the database was conducted during the period of December 2014 to February 2015. For a full list of referenced literature in this report, see below.

WHAT IS INTELLIGENCE?

In common language, intelligence is often understood as a capability of abstract reasoning, and mostly, such reasoning at an individual level. Intelligence, so defined, has been measured since the early 1900s based on the discovery of a statistical factor, the so-called *g-factor*, by Charles Spearman. His studies showed that people with a capability of advanced cognitive reasoning in one form of tests often had the same capability in other cognitive tests, hence a general intelligence or capacity for cognitive reasoning. From this, the so-called IQ or intelligence tests were developed and said to measure intelligence. Today, these tests are seen as among the most accurate (in the technical terms reliability and validity) of all psychological tests and assessments (Gottfredson, 1997), but the brains processes, underlying this intelligence are

still little understood. Current research looks, for example, at speed of neural transmission, glucose (energy) uptake, and electrical activity of the brain. However, IQ has repeatedly been strongly related to many important educational, occupational, economic, and social outcomes. Its relation to the welfare and performance of individuals is very strong (education, work life). It is also moderate but robust related to social competence, and modest but consistent related to, for example, law-abidingness. A high IQ is an advantage in life because virtually all activities in modern life require some reasoning and decision-making. The practical advantages of having a higher IQ increase as life settings become more complex, as in novel, ambiguous, changing, unpredictable, or multifaceted environments. Conversely, a low IQ is often a disadvantage, especially in a disorganized environment. Even though a high IQ is no guarantee for success in life, the odds for success in our society greatly favor individuals with higher IQs (Gottfredson, 1997, Malone & Bernstein, in press).

Intelligence as IQ is not measuring what is intelligent, but rather individuals' capabilities for intelligence, like abstract reasoning. If we, as here, are interested in what *acting intelligently* is, we need to look at other definitions of intelligence. A generally accepted definition has never been reached, but by looking at different definitions that exist, we can identify some essential criteria that need to be fulfilled for something to be called intelligent. It would be a capability

- *in the form of a cognitive process:* "Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience" (Gottfredson, 1997);
- *used in relation to an interpretation of the environment, a certain situation:* "it reflects a broader and deeper capability for

- comprehending our surroundings—catching on, making sense of things, or figuring out what to do” (Gottfredson, 1997), “the ability to learn or understand or to deal with new or trying situations” (Merriam-Webster dictionary, March 2016);
- *in which values and goals are defined:* “the ability to solve problems, or to create products, that are valued within one or more cultural settings” (Gardner, 1993), “Intelligence measures an agent’s ability to achieve goals in a wide range of environments” (Legg & Hutter, 2007);
 - *and it would be a capability used to governing mindful actions:* What defines actions as intelligent or not, is not the action or its results then luck would be intelligence, but the combination of acting with intention. Ryle (1949) uses the clown as an example to demonstrate how even “stupid” actions can be intelligent, due to their intentions: “*He trips and stumbles on purpose and after much rehearsal and at the golden moment and where the children can see him and so as not to hurt himself.*” Weick & Roberts (1993) call this tripping *heedful* and argue that the essence of intelligence is in the intended action (and as we turn our focus to collective intelligence—heedful interrelating). Heed adverbs—such as carefully, attentively, and conscientiously—attach qualities of mind directly to action. Note that “mindful governing of actions” is covering both the execution of planned actions, as well as using the defined values and goals when being reactive to changes in the environment.

Important for later discussions on collective intelligence is that for something to be intelligent it is not enough to have the potential for intelligence, as in the mind or IQ, nor is it enough to act, since it needs to be action with intention. Intelligence is doing something intelligent, by

using cognitive resources, in relation to a specific situation in which certain values or goals have been identified as desirable. This can be illustrated as in Figure 1. Although it implies a sequence, it is important to note that the reversed sequence is also relevant to understand in intelligent actions. As you act in an environment, the actions in themselves are changing the environment as well as being interpreted in relation to desired outcomes.

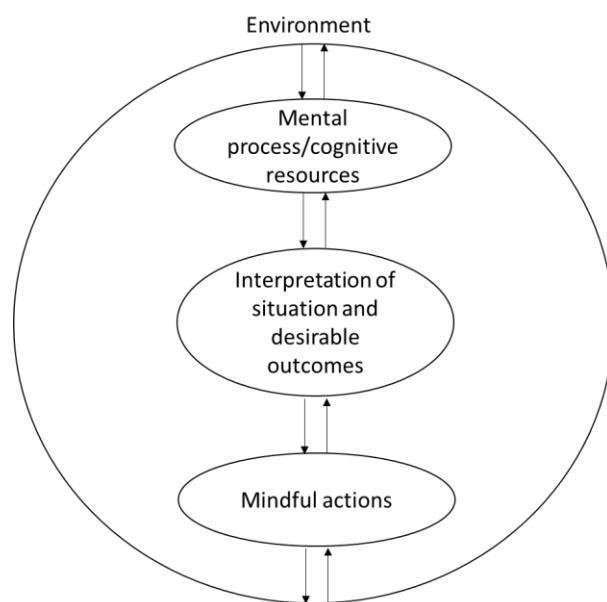


Figure 1: The process of intelligence

Based on this, we will use the following operational definition of intelligence in this report:

Intelligence is a capability in the form of a cognitive process used in relation to an interpretation of the environment, a certain situation, in which values and goals are defined and used in governing mindful actions.

WHAT IS COLLECTIVE INTELLIGENCE?

The phrase “collective intelligence,” although rather new in scientific and organizational use, has been used descriptively since at least the 1800s (Malone & Bernstein, in press). In its first use, it

described both the development of knowledge and science (Graves, 1842; Shields, 1889), the people's sovereignty in government (Pumroy, 1846), and of society as a whole: "The extent to which [society will evolve] will depend upon the collective intelligence. This is to society what brain power is to the individual." (Ward, 1906). Other early examples of the idea, but not the term, are the economist Adams' "invisible hand" (1795), "the crowd mind" (LeBon, 1895), and "collective consciousness" (Durkheim, 1893). In the early 1970s, the term "collective intelligence" began to be used in scholarly journals. It has since then been used for widely differing phenomena from insect behavior to groups of mobile robots. Here, our interest lies in groups and collective intelligence as a factor in cooperation at group level. Early scholars using this notion were Wechsler (1971), Hiltz & Turoff (1978), Smith (1994), Levy (1994), Por (1995), Isaacs (1999).

Since the definition of intelligence so far has eluded mankind, it comes as no surprise that there are also a number of different definitions of collective intelligence. Malone & Bernstein (in press) compiled a fairly current list in 2013:

1. A collective decision capability at least as good as or better than any single member of the group (Hiltz & Turoff, 1978)
2. A form of universally distributed intelligence, constantly enhanced, coordinated in real time, and resulting in the effective mobilization of skills (Levy, 1994)
3. A group of human beings (carrying) out a task as if the group, itself, were a coherent, intelligent organism working with one mind, rather than a collection of independent agents (Smith, 1994)
4. The ability of a group to "find more or better solutions than ... would be found by its members working individually" (Heylighen, 1999)

5. Collective intelligence is the *intelligence* of a collective, which arises from one or more sources (Atlee, 2003)
6. The general ability of a group to perform a wide variety of tasks (Woolley et al., 2010)
7. Harnessing the power of several people to solve a difficult problem as a group (which) can solve problems efficiently and offer greater insight and a better answer than any one individual could provide (Financial Times Dictionary, 2013)
8. The capacity of biological, social, and cognitive systems to evolve toward higher order complexity and harmony (Por, 2004)
9. A type of shared or group intelligence that emerges from the collaboration and competition of many individuals and appears in consensus decision-making in bacteria, animals, and computer networks (Wikipedia, 2013)

The authors themselves (Malone as head of the MIT Center for Collective Intelligence) give the following simple definition: groups of individuals acting collectively in ways that seem intelligent. This definition is then explained. The definition does not try to define "intelligence" since there are so many ways to define it. By using the word "acting," the definition requires intelligence to be manifested in behavior. By this definition, for example, the knowledge represented in a collection such as Wikipedia would not, itself, be considered intelligent, but the group of people who created the collection could be. The definition requires that to analyze something as collective intelligence one must identify some *group of individuals* who are involved. The definition requires that the individuals act *collectively*, that is, that there be some relationships among their activities. Finally, by using the word "seem," the definition makes clear that what is considered intelligent depends on the perspective of the observer.

THE DIFFERENCE BETWEEN COLLECTIVE INTELLIGENCE AND TEAM INTELLIGENCE

As can be seen in the spread of the definitions, what is meant by collective can refer to many things. Aulinger & Miller (2014) argue that the discussion surrounding “collective intelligence” was even “more muddled” by the release of a book by the same name (Lévy, 1994). “It seems that any collective action can be labeled as an expression of *collective intelligence*.” Therefore, they set out to answer the question: Which recommended usages for the term “collective intelligence” can be given? They suggest a clear distinction between two forms of communal intelligence: “collective intelligence” on the one hand and “team intelligence” on the other hand. Their starting point is the following definition of intelligence: “Intelligence is the degree of a living thing’s ability to overcome challenges through the processing of information.” They then argue that collective intelligence should be defined as “the degree of ability of two or more living things to overcome challenges through the aggregation of individually processed information, whereby all actors follow identical rules of how to participate in the collective.” The last part about actors following identical rules is used to delineate collective intelligence from team intelligence. It is intended to distinguish phenomena such as market economies, ant colonies, Wikipedia, and so on, where what we call individual intelligence is not a necessity. Also, by following identical rules, it is implied that it is in the rules that we find the intelligence. Opposed to that, team intelligence would then become “the degree of ability of two or more living things to overcome challenges through the aggregation of individually processed information, whereby the actors do not follow completely identical rules of how to participate in the team.” Hence, most forms of communal intelligence found in the real world are then presumably not a form of collective intelligence,

rather forms of team intelligence that are well known in corporations, football teams, orchestras, and any other group acting in a specialized manner. Collective intelligence constitutes, according to Aulinger & Miller, a very special form of communal intelligence whose initial conditions exist much more rarely than those of team intelligence. In team intelligence, we would also expect to find the intelligence in the interaction of the involved. Since they do not follow identical rules, it means that they can vary their actions, and how these are varied will be part of what intelligence is formed.

Other authors have also argued along the same lines of distinction, that what we here refer to as collective intelligence at group or micro-system level should rather be called *collective intelligence systems* (Kornrumpf & Baumöl, 2013). They argue that collective intelligence, in general terms, should be defined as “*the ability of sufficiently large groups of individuals to create an emergent solution for a specific class of problems or tasks*.” A collective intelligence system is a subset to collective intelligence in the form of a complex socio-technical system (STS) that enables the realization of collective intelligence. They distinguish this from, for example, what has been called *swarm intelligence*, as the case where the individuals themselves possess only very limited intelligence but perform complex tasks. A phenomenon which can be observed in hive building and foraging behavior by insect swarms (as well as in market economies). They argue that this term should not be used on groups of humans who are individually intelligent. Their definition recognizes that collective intelligence is at the same time a property of the collective and a potential that needs to be realized.

By detailing the definition of collective intelligence to complex socio-technical-systems, Kornrumpf and Baumöl add some distinctive and important

characteristics of collective intelligence at group level:

1. *Non-deterministic*: Here it denotes the idea that the behavior of the system cannot be predicted, even though its constituents and their individual behavior are known and even deterministic. Since the individuals are driven by their intelligence, rather than rules, their interrelating will become dynamic and unpredictable.
2. *Limited functional decomposability*: A system that is fully decomposable is one whose global functioning can be completely deduced from knowledge of the function of its sub-components. Complex socio-technical systems cannot be broken down to its details. Isolating parts of the system either leads to an entirely different system or does not reduce complexity at all. For example, understanding one single individual of the system does not make us understand anything about the mechanics of the system as a whole.
3. *Distributed nature of information and representation*: “The term distributed is used here in three similar, albeit not identical, meanings. First, to indicate that information is not stored in a centralized place within the system and instead is physically or virtually distributed to different places. Second, that information is externalized from the individual’s point of view, i.e. it is stored or represented outside the individuals’ mind. Third, that for any specific piece of information it may not be possible to decide, where it is located within the system, even though the system as a whole is aware of the respective information.” (Kornrumpf & Baumöl, 2013) Per definition, none of the individuals within the collective is capable of building a complete representation of the problem and its solution. That would violate the conditions of collective intelligence as

coordination of distributed knowledge in complex, ambiguous situations.

4. *Emergence and self-organization*: Self-organization is a way to prevent the system from drifting into permanent chaos due to complexity and randomness. In this way, the need for self-organization is also a consequence of complexity. Emergence implies that the situation, at least in part, is novel to the parts (members) of the system. The essence of self-organization is an adaptable behavior that autonomously acquires and maintains an increased order.

From this, we can summarize that collective intelligence at micro-system level is based on intelligent individuals acting in what becomes dynamic interrelating. Hence, they create a system with many different forms of drivers working at the same time. This system becomes truly complex, as we would expect if the conditions are to deal with ambiguous situations using distributed knowledge. Determinism or predictability would, under such conditions, imply that a group or micro-system display a specific pattern or solution that is predictable, although dealing with a complex and in many aspects ambiguous and unpredictable environment. The emergence of self-organization is the systems own way of dealing with the challenge of remaining a collective, in relation to the complexity of its environment, and not drift into chaos. It keeps organizing in what ultimately is a “non-organizable” situation.

We can therefore conclude two things from an organizational perspective. First, groups or micro-systems must to a certain degree be based on self-organization, since this is the only way to deal with the combined complexity of the environment and the dynamics of the micro-system itself, together creating conditions of infinite complexity. The groups or micro-systems are therefore always, to a certain degree, themselves framing their task. For the organization, this group-level creation of order

will give the final relevance (function) of the system in relation to its task. From an organizational point of view, we can therefore understand the importance of leading such systems by purpose and values, since more specific imposed orders risk ending up in conflict with their need of self-organization. If we assume that complexity today increase, and reaches further and further down in the hierarchical organizations, then less and less of the organization becomes controllable and must be relied upon to self-organize. We should expect to see organizations creating their own meaning and organizing themselves increasingly through their micro-systems, that is bottom-up. The more control imposed from above, giving more structures, the higher the complexity for the micro-systems, which in turn result in less top-down control, due to an increasing need of self-organization at micro-system level.

Second, the more intelligent the micro-systems are, the more complexity they can deal with in their process of self-organization. If we have micro-systems capable enough, they will self-organize, and the degree of self-organization will reflect the intelligence in their system, if we assume that the micro-systems know and share the organizational purpose. A highly intelligent system (having relevant resources and dynamics) will be self-organizing in a more advanced way than a less intelligent system, since we can assume that complexity is infinite. How the system (group) organizes will therefore be a reflection (and possible measure) of its capability in relation to its task. We can conclude that supporting intelligence at micro-system level is an indirect way of organizing organizations in complex environments.

In the remaining text, we will continue to use the term collective intelligence instead of “team intelligence” or “collective intelligence systems,” but where it is deemed necessary, we will add the distinction “at micro-system level.” The reason is

that the definition of “micro-system” is more relevant than “team,” to our perspective. This is because many of the cooperative moments and formats in organizations are at group level, but not defined as a specific “group” or “team” by the participants or their environment. Second, we also argue that the aggregation, or the average of collective intelligence at micro-system level, can be seen as an expression of collective organizational intelligence. It can even be seen as an average of intelligence at society level, even though it is still an aggregation of actors not following identical rules.

DEVELOPMENT OF OBSERVABLE AND MEASURABLE COLLECTIVE INTELLIGENCE

Although these definitions may make us believe that collective intelligence would be a phenomenon too complex to explain, this is not the case, but rather the opposite. According to Szuba (2001), “The scarce research done on collective intelligence can probably be explained by a widespread, unconscious fear among scientists that collective intelligence must surely be something much more complex and complicated than individual intelligence. Many people believe that collective intelligence *a priori* represents a higher level than that of the individual.” Instead, Szuba argues, “It is a paradox that the evaluation of the collective intelligence of social structures can be easier than the evaluation of the IQ of a single being.” Individual intelligence has been evaluated based only on the external results of behavior during different kinds of cognitive challenges and the problem-solving processes. However, the neuropsychological processes in the brain are still very far from being observable. In contrast, many

more elements of collectively intelligent activities and processes can be observed and, because of that, measured and evaluated. Szuba continues, “We can easily observe displacements and actions of beings as well as exchange of information between beings (e.g., language or the ant pheromone communication system). ... Collective intelligence can be evaluated with the help of abstract and chaotic models of computations and statistical evaluation of the behavior of beings in structured environments.” Szuba then develops a theoretical model of collective intelligence in social structures and a measurement; collective intelligence quotient (IQS). The model, as such, is supposed to be generic and used for any situations of collective intelligence, hence not only human interaction.

According to Szuba, the collective intelligence perspective will allow us to develop our understanding of intelligence more than if we focus on individual intelligence. When it comes to individual intelligence, there is still a question of how much stems from heritage vs. environment (heritability estimates range from 0.4 to 0.8, on a scale from 0 to 1). It seems that genetics plays a bigger role than does environment in creating IQ differences among individuals (Gottfredson, 1997), and the additional environmental factors are difficult to study and understand if we cannot study the processes of the brain in more detail. The advantage with collective intelligence is that it is created *in situ* and is based on communication. It is “open” for us to study in detail, as far as in its residence in patterns of communication. We should be able to understand what patterns of communication give a higher likelihood for intelligence, and then find ways of repeating it.

The findings of a measure for group intelligence in the form of a c-factor, comparable to the individual intelligence g-factor, raises additional questions. Citing Anita Woolley (2010), this could be not only a way of measuring the capability of groups but also help us understand and develop interventions.

For example, could a short collective intelligence test predict a sales team’s or a top management team’s long-term effectiveness? More importantly, it would seem to be an easier challenge to raise the intelligence of groups, rather than individuals. Could a group’s collective intelligence be increased by, for example, better electronic collaboration tools? Many previous studies have addressed questions like these for specific tasks, but by measuring the effects of specific interventions on a groups’ c-factor, one can predict the effects of interventions on a wide range of tasks. Thus, the ability to measure collective intelligence as a stable property of groups provides both a substantial economy of effort and a range of new questions to explore in building a science of collective performance.

A DEFINITION OF GROUP LEVEL COLLECTIVE INTELLIGENCE

Since we are here looking at the process of intelligence, ultimately to understand how to diagnose and influence the collective intelligence of groups, we want to identify what is individual and what is collective in this process. As Kornrumpf and Baumöl argue, collective intelligence as complex socio-technical systems has a *distributed nature of information and representation*. By using this understanding and going back to our model of intelligence, we can identify two truly collective processes of collective intelligence; both are different forms of knowledge coordination or integration.

The first is the process of coordinating individual mental processes in the interpretation and definition of desirable outcomes. As the definitions of collective intelligence imply, the difference between individual and collective intelligence must reside in the capacity of integrating and coordinating individual knowledge. As some of the definitions state, collective intelligence is reached

when the group somehow outperforms the capacity of any single individual in the same group. Although this measure of a specific level does not seem necessary to define collective intelligence, it does clarify that it is the combination of knowledge and mind of individuals that is used in a process of knowledge integration. Here we will call this *the collective learning process*, as opposed to an individual learning process. Second, the definitions of collective intelligence require that the individuals organize and act collectively in a coordinated manner; there is some form of relationships in their activities. As Kornrumpf and Baumöl states, the complex socio-technical system is *emergent and self-organizing*. The essence of self-organization is adaptable behavior that autonomously acquires and maintains an increased order. What prevents such systems from drifting into permanent chaos (due to the complexity and randomness) will be this adaptable behavior of its parts (members). This is the collective process of coordinating mindful actions. Upholding some form of common reference to guide the individuals' mindful actions and coordination will here be called a *representation or mental model* (Mohammed & Dumville, 2001).

It is here argued that these are the two truly collective parts of the collective intelligence process. We can also understand that the degree of mindful actions of the involved individuals, in both these moments of coordination, will be one factor creating variation in achieved collective intelligence. Whatever "resources" in the form of minds and actions the collective has access to, through its members, their ability *to become* collective will reside partly in how the individuals use each other's minds and how they coordinate their actions (see an illustration in Figure 2).

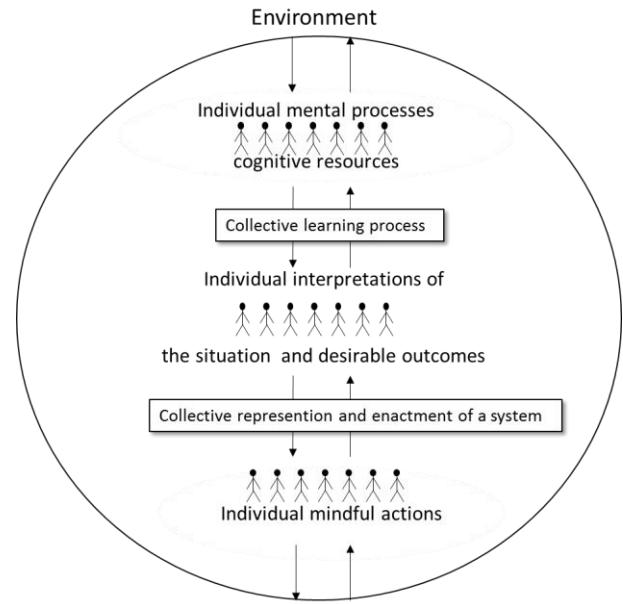


Figure 2: The collective factors in group-level collective intelligence

Based on the above, we suggest the following definition of collective intelligence at group level:

Collective intelligence at micro-system level is a process in which a group of individuals in a given situation integrate their individual knowledge resources to interpret and overcome ambiguous challenges by alternating between shared abstract thinking and coordinated actions yielding different levels of achieved knowledge integration of the available knowledge resources.

(Note that here the reversed arrows imply, for example, the need for the collective to evaluate its own actions as a collective.)

A process Collective intelligence is a process and not a property. A group is intelligent in a specific moment or not. Previously demonstrated intelligence may increase the expectancy and likelihood of intelligence, but it is not a guarantee of current and future intelligence.

A group of individuals: We limit our study to collective intelligence at group level. By a group we

here mean at least two individuals. Dyads and triads are sometimes considered special types of groups, for example, groups of more than three persons is the first level where every relationship has at least one indirect relationship. Here we judge these differences as less relevant for the definition. The upper limit of groups is harder to define, but in practice, groups of more than 12-15 individuals are subject to so many direct and indirect relationships that in many aspects they tend to act in subgroups.

A given situation: Intelligence is here seen as acting in relation to something. There is a situation in which the group can act, and the result of different possible outcomes can (at least theoretically) be valued in relation to a desired state.

Integration of individual knowledge: The major difference between individual and collective intelligence resides in the fact that there is more than one individual (i.e., a potential for knowledge integration). So, the different steps in the process of acting intelligent have the potential of using more than one set of individual knowledge (as in experience), capacity for abstract thinking and actions. From this situation arises a potential, since, in theory, two individuals could cover more knowledge than one, but, at the same time, there arises the challenge of integration and coordination between the individuals.

Interpret and overcome: The definition acknowledges that any given situation in practice is a matter of interpretation and that it is impossible to identify all possible aspects of a situation in practice. Hence, one of the factors deciding the conditions for acting intelligently must be how much of the situation can be captured in the cognitive process. In this perspective, assuming infinite complexity, the potential for a maximum level of intelligence must be on the border of chaos. If so, a group acting intelligently is not in chaos, that is, they are still capable of coming to mutual understandings and/or coordinated actions that in

time has the potential to overcome the challenge they have identified.

Ambiguous challenges: In our interpretive knowledge perspective, any situation is, in practice, ambiguous. Hence, part of the intelligence process must be to define what the challenge is, the problem setting, and what is desirable in the situation.

Shared abstract thinking and coordinated actions: Integration of knowledge can be done in two basic forms: either in the creation of knowledge, learning, or in the enactment of a knowledge system, coordinated actions. These two forms are not distinctly separated. Instead, there are collective moments of what Schön (1983), when he described the individual process of intelligence, called reflection-in-action and knowing-in-action. A specific challenge in group-level collective intelligence must be the process of coordinating between these two states of knowledge integration. When is it appropriate to challenge and question what the team is doing (reflecting, learning), and when is it appropriate to focus on enacting the system the team has developed (acting according to a representation)?

Giving different levels of achieved knowledge integration of the available knowledge resources: It is assumed that this process can create different levels of knowledge integration. Low levels of knowledge integration could mean a number of things: (1) the individuals contribute little of their individual knowledge; (2) there is little learning, as in individuals changing or developing their knowledge due to knowledge received from other individuals; (3) there is limited sharing of mental models of the situation and the system (representations); (4) the mental models are undeveloped; and (5) there is little coordination in the enactment of the mental models. Opposed to that, high knowledge integration would then be: (1) high contribution of individual knowledge, (2) intense learning, as in high change and/or

development of individual knowledge, due to receiving knowledge from others in the group, and (3) a highly shared and (4) highly developed mental model (a representation bordering to chaos), which is (5) heedfully coordinated into a collective system by the individuals. The variation between these two states could then be called variation in collective intelligence.

Note that this becomes a measure of the process mainly within the micro-system. It is defining intelligence as the utilization of internal resources, which is a measure of efficiency. It does not say anything about the results achieved, as in effectiveness. We would expect both in something we consider intelligent, at least over time. It can't be just achieving results, then luck would be intelligent. Neither can it be just doing things in the right way, since that would not include achieving what we value. On the other hand, we could expect an organization to correct itself overtime. So if we assume that our micro-systems are part of an organization, then an efficiency measure could be workable and relevant as an operational measure. It could be based on the postulate that, overtime, an organization that use its accessible (internal and external) knowledge resources (through its micro-systems) with a high degree of efficiency in both learning and enacting the organization, would be acting intelligently over time. Using such an assumption would make short term variations in results of less importance, as long as the organization continues to focus its resources on achieving intelligence at micro-system level (as defined above). Such a postulate would be useful in a complex and dynamic world in which it is difficult to create governing measures without risking to create sub-optimization at the same time.

COLLECTIVE INTELLIGENCE IN ORGANIZATIONS

Finally, before we structure and analyze the literature, in this section we will describe different perspectives on the relationship between group-level collective intelligence and organizational performance. Understanding organizations from a perspective of collective intelligence will help us understand how ultimately intelligence, residing in individuals, relates to organizational level, or how intelligence in organizations is created. We will here give some examples of discussions on these relationships:

Human organizations as complex adaptive systems. As an overall perspective of organizational development, Liang (2007) argues that we should start looking at organizations as intelligent, complex adaptive systems (iCAS). The development of humanity becoming more dependent on information and knowledge introduces intelligence as the new key to coordination. Therefore, the current concepts, theories, and practices associated with leadership strategies will also have to be transformed, and within all categories of human organizations (economics, business, social, education, and political), their members are becoming better educated and informed, and consequently, have develop potential for becoming more sophisticated interacting agents, as well as having modified expectations.

"Structure becomes function through coordination." Heylighen (2012) deepens a theoretical understanding of organizations as complex adaptive systems as he applies the "complexity paradigm on social systems".

Organizations are defined as “structures with function”: The components (agents) of the system are arranged in an orderly way (structure) to achieve a certain goal (function). However, the structures need acts of coordination to become functional. What counts, therefore, is not so much how individual agents are arranged (e.g., in a hierarchy or network), but how their actions work together in a harmonic way toward their collective goals. The emergence of collective intelligence, in an organization, is therefore intrinsically a process of self-organization by coordinating individuals using the structures of the organization.

Organizational systems as collective minds: Weick & Roberts (1993) go even deeper in developing the details of this process of intelligent adaptive systems in their concept of “*collective mind*.” This concept enables us to describe advanced collective mental processes in organizations. They use a modern aircraft carrier as an example. They motivate this choice of organization because it represents a highly complex mixture of technology, organization, and individual efforts of coordination. Hereby, they introduce the idea that “group mind”—and its intelligence—is a result of the characteristic in the interrelating behavior of the involved agents, but becoming the group mind of the organizations as these patterns of behavior are inherited over time.

Organizations as hierarchies of isomorphic systems: Gantt & Agazarian (2004) use the “*theory of living human systems*” to describe organizations as hierarchies of isomorphic systems that are energy-organizing, self-correcting, and goal-oriented, and in which decisions are made on both emotional and rational bases. Through isomorphism, the characteristics of different levels of the human systems influence each other, both upwards and downwards in the hierarchy. Hence, this theory can be used to connect the levels of individual, group, and organization.

Micro-systems as nodes of coordination in organizations: Finally, in this collection of perspectives on the relationship between group-level collective intelligence and organizational performance, Mohr, Batalden, & Barach (2004) create a workable concept for studying coordination of organizations at group level, the *micro-systems*. Micro-systems can be seen as the (identifiable) moments and nodes of coordination in complex organizations and, therefore, become central to the collective mind in complex human living systems. According to them (they study healthcare systems), organizations are collections of individual professionals who are free to act in ways that are not totally predictable; the organizational boundaries are fuzzy, in that membership changes and providers can simultaneously be members of other systems. Furthermore, given the complexity of these systems, the actions of individuals are interconnected so that the action of one provider changes the context for all the other providers.

These perspectives are developed in further detail below.

HUMAN ORGANIZATIONS ARE COMPLEX ADAPTIVE SYSTEMS

Liang (2007) argues that in today’s complex world we need to recognize that all human thinking systems and organizations are *complex adaptive systems*, and this calls for new leadership strategies which focus on intelligence. Currently, many corporations and organizations still possess the same machine-like structure that was developed to support the requirements of the industrial era. “Such a structure originates largely from the Newtonian mechanical mindset, which explains the physical world in a linear, mechanistic, orderly and predictable manner; the Descartes’ Cartesian geometry and the belief that the universe behaves

like a huge machine; and Taylor's scientific management school of thought." The consequence of the above development is the domination of leadership and management theories that believe business systems must be controlled and managed like physical instruments of production, and workers must be engineered and re-engineered to fit the mechanistic structure. However, the new environment encompasses critical features that are responsible for a need to change paradigm: knowledge-intensive, fast-changing, highly-networked, fast, and continuous learning, smarter interacting agents (at all levels), and modified expectations (for all interacting agents). All these features point to intelligence as the new focal point, and in this respect, chaos is a highly relevant scientific theory to examine and exploit.

Edward Lorenz, Mitchell Feigenbaum, Stephen Smale, and some other prominent researchers conceived the chaos theory during the 1960s and 1970s to examine phenomena that could not be explained by the classical/exact sciences. It provided a new basis for strategic thinking to emerge, supported by its core properties: consciousness, complexity, connectivity, dissipation, and emergence. The central axiom of the theory is the inseparability of order and chaos, that is, the universe is inherently chaotic and intrinsically orderly at the same time. Chaos emphasizes the importance of intrinsic human intelligence and its functions in the human world. Organizations today are embedded with sophisticated knowledge structures, information processing, and learning capabilities of their interacting agents, and the right connectivity of these systems is therefore intelligent complex adaptive systems (iCAS). The mind should become the center of our analysis and concern.

STRUCTURE BECOMING FUNCTION THROUGH COORDINATION

Based on the same complexity paradigm, Heylighen (2012) argues that organizations can be defined as "structures with function," and they become intelligent or not through coordination. The components (agents) of the system are arranged in an orderly way (structure) to achieve a certain goal (function). This is the meaning used in sociology and management: A typical organization, such as a company or government institution, consists of individuals who are arranged according to specified lines of communication and control. This structure is intended to facilitate the work of the organization toward its goals, such as providing a product or service. When we reflect a little more deeply, though, the notion of structure tells us very little about how this arrangement is supposed to contribute to the achievement of a function. The relation between structure and function becomes clearer when we introduce the notion of coordination: What counts is not so much how individual agents are arranged (e.g., in a hierarchy or network), but how their actions work together in a harmonic way toward their collective goals. At the very least, these actions should not hinder, obstruct, or oppose each other. Instead they should avoid friction. At best, they will smoothly complement each other. As such, they can solve problems together that they cannot solve individually. This bonus added by collaboration may be called synergy. Coordination can then be defined as the structuring of actions in time and (social) space to minimize friction and maximize synergy between these actions. Coordination can be subdivided into four elementary processes or mechanisms: alignment, division of labor, workflow, and aggregation.

According to Heylighen, when intelligence is localized in a single agent, it may be called

individual intelligence. When it is distributed over a group of agents, it may be called collective intelligence, as when it is only the group that can solve certain problems. Collective intelligence assumes that different agents have different forms of expertise (knowledge, information, skills). Otherwise, they would not be able to do more together than individually. Achieving collective intelligence, therefore, is a problem of *cognitive coordination between the different agents*.

An issue in the emergence of collective intelligence addresses the extent to which people manage to solve problems better as a group than individually. Examples of issues in cognitive coordination are groupthink and polarization, which is different forms of premature cognitive alignment, where groups conform to and reinforce an emerging consensus, due to social rather than task needs, and hence suppresses valuable contributions. This results in phenomena that could be called “collective stupidity” or “madness of crowds.” In conclusion, according to Heylighen, looking at self-organization in communicating groups will cast a new light on a variety of fundamental problems in organizations, including how best to achieve coordination between agents and their actions and how to maximize the intelligence of collectives.

SYSTEMS AS COLLECTIVE MIND

Weick and Roberts (1993), in their concept of *collective mind*, develop the relationship between collective intelligence and coordination in systems. The collective mind is conceptualized as a pattern of heedful interrelations of actions in a social system. Actors in the system construct their actions (contributions) in the understanding that the system consists of connected actions by themselves and others (representation) and that they interrelate their actions within the system (subordination). The intelligence resides in the

character by which this collective mind is coordinated. The authors set out to develop a language of organizational mind that enables us to describe collective mental processes in organizations. They illustrate this concept through a “reliability organization” (an aircraft carrier), but the processes of mind discussed are presumed to be inherent in all organizations (that is, in efficiency organizations as well). “What may vary across organizations is the felt need to develop these processes to more advanced levels” (Weick & Roberts, 1993).

The concept is developed by referring to other studies of group mind, such as (1) Wegner (1987), group mind as a form of cognitive interdependence focused around memory processes (transaction memory system); (2) Sandeland & Stablein (1987), group mind as connected activities encoding concepts and ideas in organizations much like connected neurons encode concepts and ideas in brains; and (3) Hutchins (1990), group mind as distributed information systems with redundant representations, showing how distributed processing amplifies or counteracts errors that form in individual units (brains).

Building their concept on these sources, they argue that the term should be “collective mind” rather than group or organizational mind since collective refers to individuals who act as if they are a group. Hence, “mind” arises through mindful coordination. Using this perspective, intelligent mind would arise from intelligent coordination. Mindful “collective minds” create mindful organizations. Yet collective mind is distinct from the sum of the individuals’ minds because it also inheres in the pattern of interrelated activities among many people. The basis for this argument is first that a “mind” is actualized in patterns of behavior. Using the clown as an example, the fact that the seemingly clumsy actions are made deliberately transforms them into intelligent actions. It is the disposition of the action—*being*

heedful—that makes them intelligent. Second, groups are defined by interrelated activity. Individuals create the social forces of group life when they act as if there were such forces. Weick & Roberts refer to Asch (1952), “We must see group phenomena as both the product and condition of actions of individuals ... There are no forces between individuals as organisms; yet to all intents and purposes they act as if there were, and they actually create social forces.” This is what creates a system, group, and ultimately an organization. The effects of this system vary as a function of the style as well as the strength with which the activities are tied together. In such a system of interrelated activities, individuals can work with, for or against each other, creating different levels of effect in the system. Collective mind exists potentially as a kind of capacity in an ongoing activity stream, and emerges in the style with which activities are interrelated. “These patterns of interrelating are as close to a physical substrate for collective mind as we are likely to find” (Weick & Roberts, 1993).

Patterns of intelligent interrelating in ongoing organizations may then be internalized and recapitulated by individuals more or less adequately as they move in and out of the system. The authors argue that “if heedful interrelating is visible, rewarded, modeled, discussed, and preserved in vivid stories, there is a good chance that newcomers will learn this style of responding, will incorporate it into their definition of who they are in the system, and will reaffirm and perhaps even augment this style as they act.”

ORGANIZATIONS AS HIERARCHIES OF ISOMORPHIC SYSTEMS

Gant & Agazarian (2004) use what they call the theory of living human systems to relate individual, team and organizational intelligence (more

specifically they focus on emotional intelligence, but here it is argued that this is relevant for all “types” of intelligence). Their theory postulates organizations, as well as communities and societies, as hierarchies of isomorphic systems. Such systems are what they call energy-organizing, self-correcting, and goal-directed. The two major constructs in the theory, *hierarchy* and *isomorphy*, are operationally defined below and can be used as building blocks for developing hypotheses about the relationship between group level collective intelligence and organizations.

Hierarchy is used here as a theoretical construct rather than referring to any organizational hierarchy per se. Every system in a specified hierarchy exists in the context of the system above it and is the context for the system below it. Mapping an organization in terms of its systems hierarchy provides a schema for looking at the isomorphy between all systems in a defined hierarchy. Isomorphy is defined as the similarity in structure and function between levels. Whatever one knows about the structure and function of one system in a hierarchy provides information about the structure and function of the other systems in the hierarchy. Seeing the systems hierarchy makes it possible to recognize the potential impact that each system level will have on the other systems in the hierarchy. For instance, when a mid-level department is in disarray because of rapid turnover in key positions, the disarray will immediately impact the larger division in which the department is nested as well as any subsystems such as work groups nested within the department.

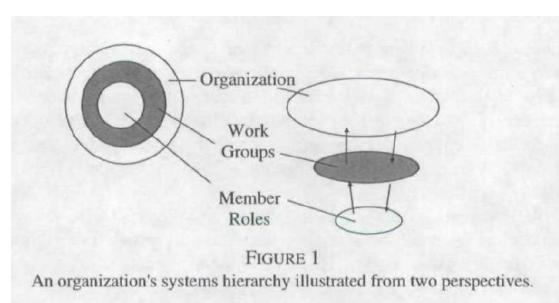


Figure 3: From Gantt & Agazarian, 2004

The systems-centered theory also introduces the concept of the *core system*, which identifies a three-level hierarchy in a living human system. Figure 3 illustrates this concept applied to an organization. The core system in this case contains the three systems: organization, work groups, and member roles. The top level defines the core system by giving it its relevant goals. For the organizational core system, the relevant goals are those of the organization. The concept of the core system provides a theoretical map that orients to the middle system as the most efficient point of change. Thus, a change intervention to the middle system need cross only one boundary to transfer the change to the system above it or below it in the core system. For example, interventions to work teams in an organization will influence more directly both the organization and the work roles that are nested in the work teams. Intervening in the organization through the individual may or may not influence the organization, and intervening to the organization may or may not influence the individual, intervening to the work team is more likely to influence both the members and the organization. The core system is defined according to the change goals. Once the relevant core system in a change strategy is determined, it is also possible to identify the middle system within the core system. Since the middle system of the relevant core system is theoretically the most efficient point of intervention (as it shares boundaries with the systems above and below it), it would then be the primary target of the change strategy.

The theory of living human systems is one way of describing the relationship between the individuals, the micro-systems, and the organization. As an example of how intelligence relates to this, we can use what the theory calls *contexts* and *contextualizing*. Each subsystem in a core system introduces a different context.

Different contexts have different goals and contribute different perspectives. How a department views a reorganization is different from the work team's perspective and still different again from the perspective of the individual and the organization as a whole. Being able to change perspectives is critically important in today's workplace where rapid changes require employees to change roles and contexts frequently. Hence, a critical part of intelligence, as we define it, would, therefore, be contextualizing, that is shifting perspectives to view the system from different hierarchical levels, learning how perceptions change as the context changes. For example, a work team contextualizing would examine a proposed change from at least three perspectives: their own perspective, their department, and from the individual roles within the group. Addressing the fact that contexts shifts, the work team would not be team-centered but systems-centered, so that decisions can be made or implemented with a broader perspective. "Thus, learning to shift to a systems-centered perspective from a predominantly self-centered, team-centered, or organization-centered perspective, introduces additional and significant resources to the decision-making process." According to Gantt & Agazarian, there is an inverse relationship between contextualizing and personalizing, and the greater the proportion of contextualizing in an organization, the greater the emotional intelligence. Returning to the example above, if the work team reacts to the new proposal for inventory only from the perspective of its impact on the work team, its range of exploration will be limited and personalized. To the extent that the team attends to the perspectives of the other organizational contexts (departmental and individual stores), personalizing will be reduced, and the potential for collective intelligence increased. Instead of seeing organizational intelligence as additive and tied primarily to resources, Gantt & Agazarian propose that organizational intelligence is an emergent

system phenomenon that relates to the interaction of the whole and through the interactions within and between system components. Emergence refers to a phenomenon that, instead of being predictable from summing its components, arises from interactions.

MICRO-SYSTEMS AS NODES OF COORDINATION IN ORGANIZATIONS

A more practical approach, but following the thinking of previous theories, is the concept of micro-systems. Mohr, Batalden, & Barach (2004) suggest how a relationship between group-level collective intelligence and organizational performance can be seen in healthcare institutions. These are described as “organizations facing challenges in providing safe patient care in increasingly complex organizational and regulatory environments while striving to maintain financial viability.” According to them, clinical micro-systems provide a conceptual and practical framework for approaching organizational learning and delivery of care in healthcare organizations that are often “complex, disorganized, and opaque systems to their users and their patients.” Such systems should therefore rather be seen as “conglomerates of smaller systems, not coherent monolithic organizations.” The core elements of a clinical micro-system are a focused type of care, clinicians and staff with the skills and training needed to engage in the required care processes, a defined patient population, and a certain level of information and technology to support their work. What differs across micro-systems is the ability of individual caregivers to recognize their efforts as part of a micro-system as well as the micro-system’s level of functioning. Healthcare organizations are composed of these multiple, differentiated, autonomous micro-systems. The assumptions of this concept are:

- Bigger systems (macro-systems) are made of smaller systems
- These smaller systems (micro-systems) produce quality, safety, and cost outcomes at the frontline of care
- Ultimately, the outcomes of the macro-systems can be no better than the micro-systems on which they are formed
- The loyalty of most micro-system providers is first and foremost to their patients and the micro-system, and rarely to the larger macro-system.

The authors argue that this requires interventions at the micro-system level, if the organization wants to improve. However, this does not mean that the micro-system functions independently from the other micro-systems or its macro-system. The micro-systems within the macro-organization are interconnected. “The role of leadership is to set the general tone of the organization, to facilitate the interconnections between the micro-systems, and to cultivate learning disciplines in the organization.” According to the concept of micro-systems, the level of coordination in the “frontline,” as well as the performance of the organizations, is seen as aggregations of the performance in the micro-systems.

SUMMARY OF PERSPECTIVES ON COLLECTIVE INTELLIGENCE IN ORGANIZATIONS

If we summarize these theories, the relationship between individual intelligence through group level collective intelligence to organizational intelligence or performance could be explained in the following way:

Organizations are structures with function (Heylighen). However, these structures are coordinated into function. The quality of this coordination can be expressed as being intelligent

or unintelligent. Different forms of friction or pre-aligned cognitive coordination (for example groupthink) cause the latter.

Since our historical and current view of organizations, according to Liang, has a Newtonian mechanical mindset that explains the physical world as linear, mechanistic, orderly, and predictable, our ideas of leadership tend to problematize structure and resources in the process of building organizational “machines.” Such a perspective miss the idea of the “parts” and their contribution to coordination, since the parts of a machine are not seen as coordinators. They just “do” what is planned for them to do. Machines are not intelligent. With increasing complexity, organizations must focus on ad hoc or complementary coordination, since this will be the source of intelligence in a dynamic and unpredictable environment. Against this background, Liang argues for a leadership strategy looking at organizations as intelligent, complex, adaptive systems (iCAS).

To understand human systems at a deeper level, Weick and Roberts developed the concept of “collective mind.” They explain the interrelated behavior of individuals in organizations as being based on a representation from which they form the contribution and subordination of their actions. The “mind” or intelligence of this system will be in the character of the interrelating (i.e., coordination). Intelligence can be inherited between individuals through the patterns of behavior in the organization.

The isomorphism of different system levels in organizations is further explained by Gantt and Agazarian, introducing the core system as the natural focus for interventions in human systems rather than following formal hierarchies.

The last paper, by Mohr, Batalden and Barach, discuss the same concepts from a more practical perspective, introducing how health care

organizations can be understood and explained as aggregations of micro-systems, and that the safety and performance level of these organizations resides at this level.

Together, these theories all represent efforts to describe the relationship between individuals, moments of cooperation, and organizational performance. All of them argue that the organizational intelligence is the sum of the coordination processes taking place at the level in between organization and individual; in this paper, we will use the term *micro-system*. All of them describe this level as a process of coordination, and as such it will be dependent on the coordinators' understanding of the organization and what needs to be coordinated. Hence, we can argue that collective intelligence on the micro-system level is a process of coordination and as such will vary in quality in relation to factors such as the understanding of the situation (contextualizing, representation), the ability to learn, and the ability to act as a system (acting and coordinating).

Structures are essentially tools for managing organizations. However, an organization comes to life because of all the actions and micro-moments of coordination happening every day, following these structures or not. Since the individuals of the organization will experience the organization at different levels (as a whole, departments, groups, and so forth.), they will see and follow patterns, visible to them in the local and social contexts in which they work daily. It is here that the micro-moments “talk back” to them. Their actions and the actions of others are created on an everyday basis, but at the same time tend to follow inherited patterns. Therefore, micro-actions both create “the whole” and follow “the whole.” The intelligence of organizations must, therefore, reside in the sum of the intelligence of the micro-systems; like in an average, as well as in the patterns they create, as something above the micro-system level. Hence, the isomorphic relationships give us

points of influence in both the organizational pattern and the micro-moments.

STRUCTURING AND ANALYZING THE LITERATURE

Collective intelligence, as we define it here, is based on the condition that different agents have different forms of expertise, knowledge, information, and/or skills, so achieving collective intelligence must be a problem of coordination. According to Heylighen (2012), coordination can be split into the four basic mechanisms: alignment, division of labor, workflow, and aggregation. Following such a flow of coordinating activities, Surowiecki (2005) also proposes a set of requirements that a group or collective of individuals must fulfill to exhibit collective intelligence (or *wisdom of crowds*, as he calls it).

- *Diversity*: The more diverse the knowledge and experience possessed by the different members of the group, the more the group as a whole knows. Diversity also lessens its members' likeliness to overlook certain aspects or to fall prey to the same bias.
- *Independence*: Individuals should express their contribution as much as possible independently of other members of the group. Otherwise, there is a risk of premature alignment between the contributions themselves rather than between the targets of the contributions.
- *Decentralization*: make it possible for individuals to gather and process their information in parallel and, therefore, cover a wider range of aspects in relation to the task.
- *Aggregation*: Collective intelligence requires an effective mechanism (such as voting, averaging, or discussing) for synthesizing a

diversity of individual opinions into a single, collective answer.

Achieving collective intelligence could therefore be said to be the decentralization and aggregation of diverse, independent sources of cognition and action.

To create a unifying model of the literature on collective intelligence, we use this set of requirements to sort the literature into two basic dimensions. The first is the *knowledge integration dimension*. We identify two different forms of knowledge integration: (1) the learning process (coordination of cognition, resembling aggregation and alignment), when the representation (shared mental model) of the collective is created, developed, and/or changed, and (2) enactment of a knowledge system (coordination of action, resembling division of labor and work flow), when the shared mental model is used to guide individual contributions and subordination into a collective mind.

The second dimension is the *collective dimension*. As Weick and Roberts describe, the collective mind is both the (1) on-going subordinated individual contributions in relation to the representation; the collective mind is recreated by the actions of the individuals continuously; it is also (2) "inherited" as a pattern of behavior to new individuals, and this inherited pattern is as close to the entity "collective," "group," or "team" as we can ever get.

Together, this gives us a matrix with four dimensions of collective intelligence on the micro-system level (See Fig. 4):

- 1) The starting point will be *collective intelligence as the learning process*, as in thinking or cognitive reflection; it is an analytical process to deal with experienced problems or challenges.

Collective intelligence, in this form, is a process with several individuals, or brains, using their knowledge, as opposed to the same process of one individual with one brain and one set of knowledge. The basic question in this dimension is how learning changes when it is a group as opposed to an individual. Selection criteria: studies focusing on learning as sharing and changing distributed knowledge, problem-solving, decision-making, and so forth.

- 2) Collective intelligence as *the enactment of a human system* develops the problem to include not only learning but also action. It is not only an analytical process; it is also the capacity to act collectively in situations. This perspective, therefore, develops the basic question to include acting collectively as a necessary requisite for collective intelligence. Collective actions are based on individual actions somehow being coordinated, which means that some form of shared representation or mental model governs them. Such a representation needs to reflect both the situation, the organization, and allow for individual initiatives (acting and/or reporting back to the organization), if the task is dynamic. A shared representation could, therefore, be expected to precede collective actions, that is, be a result of some common learning process, but it is also a result of the ongoing process in relation to the task. The representation is therefore also necessary to give the learning process some form of context. The problem setting of this perspective is how individual actions are coordinated to become a collective system, and what makes this system a more or less intelligent system.

Selection criteria: studies focusing on enacting a system, representation, mental models, coordination and so forth.

- 3) Collective intelligence as patterns of behavior. The group as a system can be seen as a pattern of actions, which is the perspective we use if we assign attributes to groups, like for example psychological safety or goal orientation. If we ascribe the group attributes, we assume that this is something that is repeated in the group behavior, that is, the group has some form of pattern that we can characterize, and that can be inherited even if we change the members of the group. The problematizing here is what attributes and characteristics a group need to have to be intelligent.

Selection criteria: studies focusing on factors at group level, like psychological safety, explaining group behavior.

- 4) Collective intelligence as individual coordination. The final perspective sees the group as a result of individual micro-actions. Since individuals in any collective system always have a certain level of independence in their behavior (discretionary behavior), groups could be explained by factors influencing these choices of actions. (As they turn into patterns they become characteristics of the group.) This could be seen as the last and perhaps deepest level of the analytical perspective of collective intelligence. The problematizing is in what way individual actions contribute to collective intelligence.

Selection criteria: studies focusing on the contribution of the participants to collective phenomena, for example, organizational citizenship behavior (OCB).

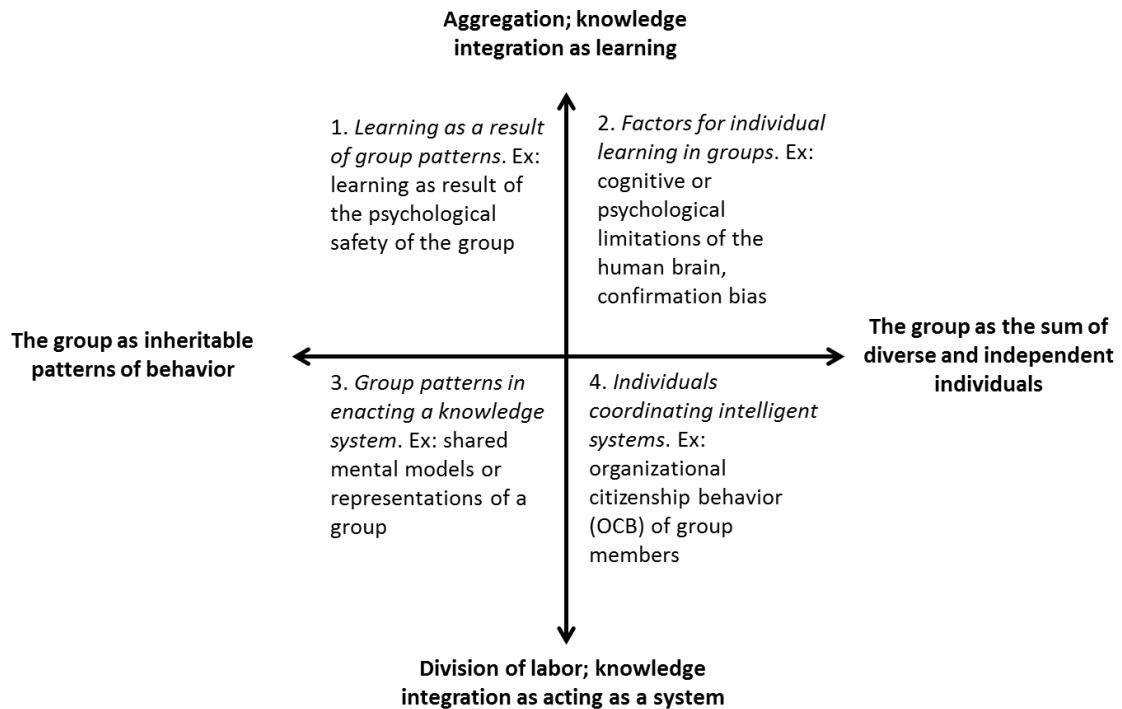


Figure 4: Four dimensions of collective intelligence

These four perspectives are not mutually exclusive. Instead, it is rather two perspectives in each dimension describing the same phenomena, but from different perspectives. Is intelligence thinking or acting? The answer is, of course, both, what has been called mindful action or action with intention. The same goes for whether a group is a “pattern” or the result of individual actions. Both perspectives are relevant in understanding a group. However, this sorting is still meaningful since we want to identify workable factors that will, at the end, allow us to understand, measure, and intervene in collective intelligence. By using these four perspectives, we can sort the discussion of collective intelligence at a lower and deeper level of analysis and yet relate to the “bigger picture,” organizational intelligence. For each dimension, we will sort the literature *first* to extract factors relating to collective intelligence in this perspective and, *second*, to extract ideas on how to stimulate collective intelligence.

1. LEARNING AS A RESULT OF GROUP PATTERNS

Reagans et al. (2005) ask the question why some organizations learn faster than others. They connect this to the interplay between three levels of organizational learning: individual, team, and organization. They argue that researchers who study experience *working together* (team learning) traditionally have provided two distinct explanations for why this improves performance. Each explanation highlights the ability of individuals to coordinate their activity. The explanations, however, emphasize different mechanisms responsible for improved coordination. According to Reagans et al., researchers who study *group dynamics* emphasize the importance of knowing “who knows what.” Teams composed of individuals who have

experience working together have a more accurate and shared sense of who knows what on the team. Effective teamwork results from identifying the right roles and responsibilities and assigning the most knowledgeable person to each role. Researchers who study experience working together in the *market context* emphasize the importance of transaction partners learning how to govern their interaction. Multiple exchanges increase the likelihood of trust, and trust promotes the exchange of “private” knowledge and information. Sharing private knowledge provides transaction partners with the opportunity to learn how to govern their relationship. Instead of being governed by the *market*, the transaction is governed by a relationship-specific logic and terms of trade. Researchers in this tradition emphasize the importance of relationship-specific heuristics, the knowledge embedded in the tie that connects people performing distinct roles.

In their paper, Goyal & Akhilesh (2007) discuss how value in the economy is transferred to learning phenomena such as innovation and creativity. However, according to them, all factors (internal as well as external) influencing the innovativeness of teams or groups lead to one *general ability* which in turn can be conceived as composed of three different and interrelated abilities: cognitive intelligence, emotional intelligence, and social capital (note that therefore, in this report, their discussion on innovativeness is interpreted as equivalent to a discussion on intelligence). The basis for this argument is that people cannot work with knowledge, in social situations, without the knowledge becoming dependent on the individual's relational and identity processes. According to the authors, the general and inclusive

nature of the variables proposed in the model hold promise for proving more stable explanations, and thus a more robust model, of the highly complex phenomena of work team innovativeness, both for research, intervention, and practical purposes. They argue that most studies, so far, have focused on narrow and specific variables in relation to innovation. Focus has been more on innovation as the output and less on the process of innovation, thus keeping the actual process obscured. The inherent complexity of the concept of innovation implies that there can be a large number of specific input as well as output variables related to innovation. So, an important step toward theoretical integration would be first to study more encompassing and general factors in the process of innovation.

They propose that many factors from various domains contribute to the team's overall competence, as has been shown by a vast literature on teamwork and group dynamics. A few factors which have been most studied and well-established include group size, group history, group cohesion, leaders' behavior, control mechanism, group norms, goals, shared vision, heterogeneity of members, organizational culture, task type, individual member characteristics, and so forth. They propose that the contributions of all these factors in terms of various kinds of competencies boils down to three different, interrelated and general abilities, which include the cognitive intelligence, emotional intelligence, and social capital of the team/group. Most other behaviors and potentialities of the team can be explained in terms of these general abilities (see Figure 5 below).

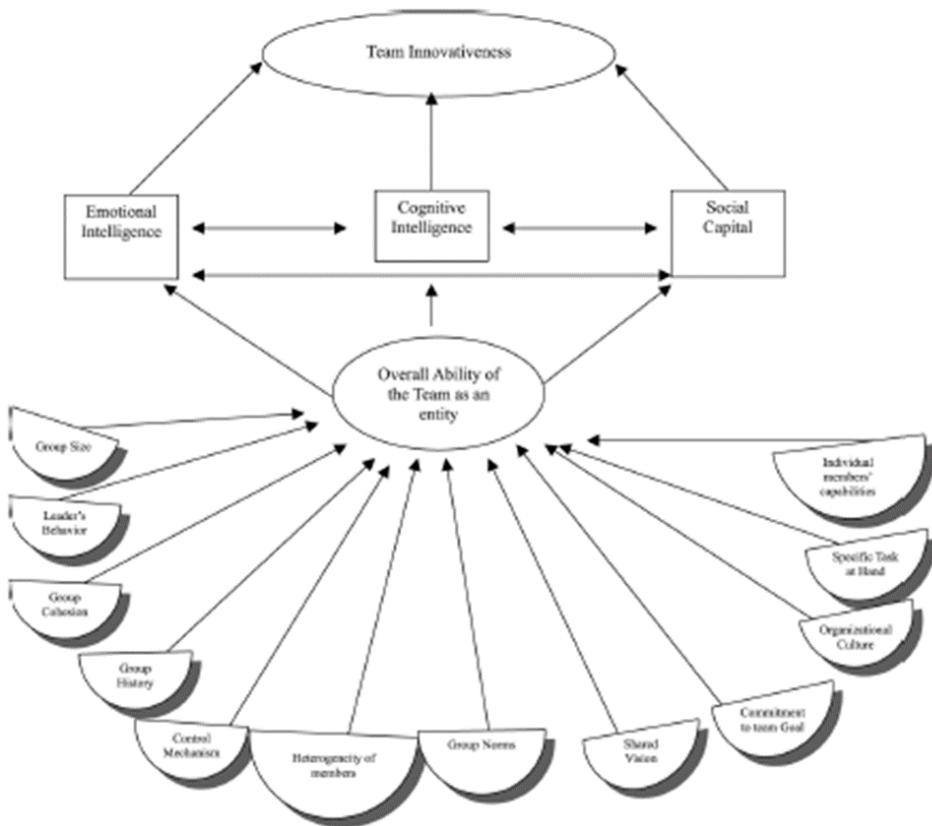


Figure 5: From Goyal and Akhilesh, 2005.

After this introductory perspective, we will look at a number of different factors that have been identified as influencing collective learning ability at group level, organized in according to psychological, cognitive , and process factors.

PSYCHOLOGICAL FACTORS IN GROUP LEARNING

Since the early 1990s, when Salovey and Mayer coined the term *emotional intelligence* (EI) (Salovey and Mayer, 1990), there has been a tradition of research on the role of non-cognitive factors helping people to succeed in both life and the workplace. Salovey and Mayer (1990) described emotional intelligence as a form of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and action.

Such emotional factors have substantial influence if the activity demands high levels of personal commitment, self-confidence, interpersonal trust, free communication, and proactive behavior (as in the innovative processes Goyal and Akhilesh discuss above). Innumerable kinds of emotions and emotionally related behaviors, such as ego, anger, anxiety, fear, conflict of values, competition, and so forth frequently arise in a collective knowledge process. The effectiveness of performance in knowledge-intensive organizations, therefore, draws heavily on the emotional capability of the people involved and how they facilitate the quality of interpersonal functioning, such as the group intelligence.

Emotional perception, facilitating cognition, emotional understanding, and emotional management are the four dimensions of EI, according to Mayer and Salovey (1997). Emotional perception (EP) involves the ability to notice

emotions accurately in the self and environment and to express them well in social settings. Emotional perception should aid in discriminating between environmental threats and benefits. Facilitating cognition (FC) involves using and generating emotions to assist cognitive processes. Emotional understanding (EU) involves identifying emotions and being clear about ways they are formed and blended as well as their causes and consequences. Being able to understand emotions helps individuals reduce unproductive emotion-focused coping. Emotional management (EM) involves maintaining and altering emotions in the self and others (enhancing positive or reducing negative emotions as needed).

Gant and Agazarian (2004) introduced in their paper a system-centered model (see above) of emotional intelligence which makes it possible to consider not only the emotional intelligence of individuals, but the emotional intelligence of work groups and organizations, and how these relate. According to them, individuals contribute the energy in organizational emotional intelligence. Yet, equally important, emotional intelligence in organizations is a dynamic output of the function, structure, and energy of the organizational systems themselves. This system-centered perspective on emotional intelligence enables emotional intelligence to be viewed at all system levels in the organization, including individuals, work teams, and the organization itself.

Druskat and Wolff (2001) focused on emotional intelligence in groups, proposing that organizational group norms support the awareness and regulation of emotions in groups' emotional intelligence. Group emotional intelligence relates to how groups manage individuals' emotions, regulate emotions, and how groups interact with others outside the group boundaries.

Lee, Park, and Lee's study from 2013 supports the findings that social capital and different forms of intelligence relate, but take on a leader perspective.

Their study shows that *group social climate* decides if the competence of the leader will influence group performance or not. In their study, they apply this social capital theory to IT service team environments. Team social capital is positioned as mediator between leadership competencies (i.e., the leaders emotional and cognitive intelligence) and team project performance. The results show that emotional intelligence competencies of project managers directly influenced project performance. Cognitive intelligence competencies of project managers had direct influence on project performance in short-term projects, but indirect influence only via the accumulated team social capital in long-term projects.

In 1999, Edmondson presented a model of team learning and tested it in a multimethod field study. It introduced the construct of *team psychological safety*—a shared belief held by members of a team that the team is safe for interpersonal risk taking—and modeled the effects of team psychological safety and team efficacy together on learning and performance in organizational work teams. Results of a study of 51 work teams in a manufacturing company, measuring antecedent, process, and outcome variables, showed that team psychological safety was associated with learning behavior, but, surprisingly, team efficacy was not when controlling for team psychological safety. As predicted, learning behavior was the mediator between team psychological safety and team performance.

Barczak, Lassk, and Mulki (2010) explore in their study the connection between team creativity, team emotional intelligence, and *team trust*. Using a survey of 82 student teams at a large university in the northeast United States, their findings suggest that team emotional intelligence promotes team trust. Trust, in turn, fosters a collaborative culture which enhances the creativity of teams. They conclude that the results of this study present a

more nuanced and complex picture of the antecedents of a team's creative output. Specifically, their results indicate that emotionally intelligent teams create both cognitive and affective team trust. Cognitive trust is based on a member's perception of the reliability and competence of his/her peers. When team members exhibit professional behavior by managing their own emotions and those of their colleagues, such as being deliberate in their decision-making by examining all sides of the argument, they are likely to be trusted and relied on for their competence and ability. On the other hand, affective trust is based on emotional bonds resulting from interpersonal care and concern for each other. When team members are aware of their own emotions and can manage others' emotions, they can empathize and provide support, thereby creating affective team trust.

In a study of 228 knowledge workers from nine Korean organizations, Yoon, Song, Lim, and Joo (2010) confirm the isomorphic view of organizations, when they show that *culture and collaboration practice at the organizational level* influence learning and creativity at team level. A learning organization has been defined as an ideal structure and culture that continuously acquires, processes, and disseminates knowledge about markets, products, technologies, and business processes. In the study, they found support for a supportive learning culture having a positive and direct influence on team creativity and the teams' collaborative knowledge creation practices. It also had, as predicted, an indirect influence on team performance through these variables of team creativity and knowledge-creation practices.

Concluding the studies relating psychological factors to group learning patterns, we see that emotional intelligence in all forms seems to matter; as a team factor, team leader ability and organizational culture. It is the creation of trust,

both cognitive and affective, and perceived psychological safety that seems to be the critical factors to support learning behavior.

COGNITIVE FACTORS AND GROUP LEARNING

In this section, we look at the second general ability of groups (according to Goyal & Akhilesh), *cognitive intelligence*. While some researchers argue that learning is essentially an individual activity, most theories of organizational learning stress the importance of collective knowledge as a source of organizational capability. Organization and management researchers have therefore extended the cognitive analysis to the group and organizational levels. Their analysis suggests that groups and organizations develop collective mental models (Senge, 1990) and interpretive schemes which affect group decision-making and action. Collective cognition differs from individual cognition because it encompasses interaction and social dimensions; thus, much of the research has focused on relations and connectedness to account for the processes in the formation of collective cognition and knowledge structures. However, below we present some of the factors related to the cognitive conditions.

In a study of 83 teams from eight organizations, Kearney, Gebert, and Voelpel (2009) examined team *need for cognition* (defined as the tendency to engage in and enjoy effortful cognitive endeavor) and how this worked as a moderator of how team characteristics (age and educational diversity) influenced: (1) elaboration of task-relevant information and (2) collective team identification, both seen as critical processes of team performance. It seems as if this attitude toward understanding (need for cognition) has an important effect on how the knowledge resources of the team will be perceived and used. Age and educational diversity were positively related to

performance when team need for cognition was high. Need for cognition represents a stable, but not invariant, intrinsic motivation to process a broad range of information. What is interesting is that this tendency, which says little about differences in ability, can, according to Cacioppo et al. (1996), be developed or changed. Individuals who have a high need for cognition naturally enjoy thinking, but individuals with a low need for cognition engage in cognitive endeavors mostly when there is some incentive or reason to do so (Petty et al., 2009). This study seems to support that an important group factor, possible to influence; the cognitive learning attitude, influences the groups' possibilities for using their diverse knowledge resources.

Another form of cognitive factor is the *team goal orientation*. Gong, Kim, Lee, and Zhu (2013) used a multilevel approach to examine how team goal orientation may relate to team creativity. Team goal orientation captures the shared understanding of the extent to which a team emphasizes learning or performance goals. This helps to facilitate group decision-making, collaborative problem-solving, and intragroup coordination. Goal orientation can be "cued" by situational factors such as leadership, assigned goals, and an evaluation focus (Bunderson & Sutcliffe, 2003; Gully & Phillips, 2005). Data were collected from 485 members and their leaders within 100 R&D teams. The results indicated that

goals on team learning and team performance approach were positively related to both team creativity and individual creativity through the process of team information exchange. If we summarize these two cognitive factors, need for cognition and goal orientation, they seem to contribute both to initiating and developing the communicative dynamics of teams (the use of knowledge resources and the team information exchange), which in turn relates to team performance. It also seems possible that both these cognitive factors can influence and stimulate, indicating that there should be several possible means to support and initiate communicative dynamics at the micro-system level.

Oorschot et al. (2013) introduce a negative cognitive factor, the *information filters*. They conducted a longitudinal process study of one firm's failed attempt to develop a new product. Their analysis suggests that teams in complex dynamic environments, characterized by delays, are subject to multiple *information filters* that blur their perception of actual project performance. Consequently, the teams do not realize their projects are in trouble and repeatedly fall into a "decision trap" in which they stretch current project stages at the expense of future stages. Because of these information filters, teams fail to notice what is happening until it is too late. In some cases, these problems lead to the termination of projects³. Previous research indicates two main

³ For example, in 2002, \$55 billion was wasted in terminated information technology projects in the United States (Pan & Pan, 2006). Boulding, Morgan, and Staelin (1997) and Hitsch (2006) cited project failure rates of at least 35 percent across different industries. Barczak, Griffin, and Kahn (2009) found that only about 59 percent of newly commercialized products are considered to be successful. This rate of success remained largely

unchanged between 1990 and 2004, even though the number of firms using formal processes, methods, and techniques to improve new product development increased from 54 to 69 percent during the same period. Barczak et al. (2009) reported that the best-performing firms in their research sample used more formal processes, tools, and techniques, but their survey did not clarify how and why this relationship was positive.

reasons why it can take a long time before a team realizes a project is in trouble and needs to be terminated: escalation of commitment (Staw, 1976) and groupthink (Janis, 1982). The theory of escalation of commitment focuses on why managers continue to invest in projects in the face of negative information. Groupthink is a form of self-censorship through illusions of unanimity, direct pressure on dissidents, and reliance on self-appointed "mind guards." However, the results of this study on information filters indicate that escalation of commitment and groupthink cannot plausibly explain failure to realize that the project was in trouble. Instead, this is explained by the anatomy of a decision trap. The difficulty in project environments lies in seeing through three different types of information filters: *the mixed signals filter*, *the waterbed filter*, and the *understaffing filter*. The mixed signal filter accounts for the team's focus on the flows, rather than the accumulations, of positive and negative information. Because these flows were mixed, it was difficult for the team to perceive that the situation was gradually deteriorating. The waterbed filter explains why fundamental problems that seem to be solved reemerge nonetheless in a different manifestation (e.g., staffing problems "disguised" as schedule problems). The understaffing filter accounts for the difficulty of an understaffed team in forecasting the productivity of a fully staffed team. Misinterpreting project information, combined with the illusion of control, caused the team to fall into the decision trap of stretching the current stage while squeezing the next, supposing that overall project slack was protected. The ambiguity of information and the long time lags between decisions and their effects in this dynamically complex system did not facilitate learning, so the team fell repeatedly into the same decision trap.

Furthermore, even the best-performing firms had a failure rate of 25 percent.

Concluding these three examples, we can see that cognitive factors can both support the development of communicative dynamics and create hindrances. In both cases, the communicative dynamics between the available knowledge resources mediate the relationship to team performance.

PROCESS AND ORGANIZATIONAL FACTORS IN RELATION TO GROUP LEARNING

In this section on process and organizational factors of group learning, we can introduce the third collective ability that (according to Goyal and Akhilesh) explains the general ability of group functionality; social capital. Bourdieu (1986) defines social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition." Putnam (1995) defines social capital as "the collective value of all 'social networks' and the inclinations that arise from these networks to do things for each other," and argues that there are two main components of the concept: (1) *bonding* social capital, referring to the value assigned to social networks between homogenous groups of people and (2) *bridging* social capital, as in social networks between socially heterogeneous groups, for example, choirs and bowling clubs. A wide range of different aspects and components of "social capital" that have been studied include the following: social networks of individuals and organizations, social interaction, familiarity and interpersonal trust,

group cohesion, diversity, strength of relationship, position in the network, group identification, strategic communities, self-organizing innovation networks and so forth. The aspects of social capital mentioned above have been shown to influence the process of innovation, creativity, creation of knowledge and intellectual capital, knowledge sharing, team learning, speed to market, new product success, and social appropriation of broad knowledge base and competence building (Goyal & Akhilesh, 2007). In sum, there have been extensive theoretical arguments for social capital and its effects on processes and outcomes related to innovation. The generic nature of the concept of social capital and its relation to a wide range of activities and outputs suggests that social capital must underlie, overlap, and be a result of cognitive and emotional functioning of social units such as groups.

One rather obvious way in which the social capital of groups is critical for learning is that it connects knowledge and supports so-called *distal learning*. There is increasing recognition that group members learn not only within the group (i.e., *local learning*), but also externally (i.e., *distal learning*), and these two group-learning processes may facilitate group performance in different ways. Despite this recognition, there is much that is not understood about whether they complement or inhibit each other in affecting group performance, and whether group social and task conditions that foster one type of learning do so at the expense of the other. The findings from a field study (Wong, 2004) of teams from four firms show that (1) local learning and distal learning are positively related to group efficiency and group innovativeness, respectively; (2) distal learning negatively interacts with local learning to impede group efficiency; and (3) high levels of group cohesion promote distal learning but diminish local learning. The study reframes the common belief that local and distal

learning are mutually compatible learning processes by demonstrating the negative interaction effect between them. An interesting result was that social cohesion may not always be beneficial for group learning. There was an unexpected finding of an inverted U-shaped relationship between group cohesion and local learning that suggests that excessive social integration in the group reduced mutual learning among members. However, in the case of distal learning, a higher level of group cohesion promoted greater external knowledge sharing. This also counters the popular belief that higher internal group cohesiveness fosters greater resistance to external ideas. Overall, these findings suggest that there are not only performance trade-offs to engaging in either only local or distal learning but also performance disadvantages to engaging in both types of group learning because distal learning impedes local learning from achieving a high level of group efficiency. Even though local learning involves engaging in exploratory-oriented behaviors such as trying new ideas and reflecting, the more circumscribed knowledge space likely to be accessed in local learning (i.e., only sampling the knowledge of individuals within the same group) implies that this should influence the improvement of efficiency rather than the innovativeness of the group. Given that distal and local learning are significant for different performance dimensions, the findings imply that learning-oriented teams with emphasis on developing new competencies should engage in greater distal learning, and mastery-oriented teams with emphasis on perfecting current competencies should engage in greater local learning.

Another important aspect of social capital is that it seems to fill a function for the performance-critical factor of interrupting work processes for reflection, which, among other things, works to

avoid building information filters (See for example the study of Oorschot et al. above). In a study of 42 random four-person groups, Okhuysen (2001) presents evidence for *self-generated interruptions* to be a critical factor in group performance and decision-making. As group members initiate self-interruptions, they switch their attention to social concerns (in familiar groups) or discussion instructions (in groups using formal interventions). During such interruptions, members evaluate activities, propose alternative approaches, and change working strategies. Results suggest that both familiarity (social capital) and formal interventions lead to superior performance through these interruptions. However, an interesting finding, in the same study, is that using a formal intervention in familiar groups may hurt performance because pre-established interaction patterns, socially developed, are altered.

Another form of social or organizational factor, *subgroups*, was studied in 156 teams from five pharmaceutical and medical products firms by Gibson & Vermeulen (2003). Their study confirmed that moderately strong demographic subgroups in teams fostered learning behavior. In their study, they examine the relationship between subgroups and team learning behavior, defined as a cycle of experimentation, reflective communication, and codification. They develop the construct of *subgroup strength*, defined as the degree of overlap across multiple demographic characteristics among a subset of team members. Contrary to conventional wisdom, they find that the presence of subgroups within a team may stimulate learning behavior. They also found that organizational design features, such as performance management by an external leader, team empowerment, and the availability of a knowledge management system, may have different effects on teams, depending on subgroup

strength. Also, both very homogeneous and very heterogeneous teams were more inclined to engage in learning behavior, but only if they controlled for the concurrent effect of subgroup strength. Overall, this study contributes to the literature on team composition, design, and learning by highlighting the importance of subgroups for understanding team behavior.

A study of 92 work teams in Taiwan (Huang, 2012), a Chinese cultural context, investigates how *team conflicts*, in the form of task and relationship conflicts, relates to team performance. Results show that relationship conflict has a significant and negative relationship to team performance, while task conflict has no significant relationship to team performance. However, the results show that team goal orientation moderates this relationship between task conflict and team performance. For teams with high learning orientation, task conflict positively relates to team performance, whereas for teams with low learning orientation, task conflict will lower team performance. In teams with high-performance orientation, task conflict negatively relates to team performance, whereas for low-performance orientation teams, task conflict will facilitate team performance. When team performance orientation is high, this also increases the detrimental effect of relationship conflict on team performance. These are interesting results, confirming that the representation or setting of the team, as in learning or performance orientation, has a direct impact on how conflicts will be seen and in the end influence performance. However, it is noteworthy that relationship conflicts always had negative impact on performance. Relationship conflict ultimately leads to a limitation on how much information the team processes. When relationship conflict occurs, team members spend time and energy on interpersonal issues rather than discussing tasks and making decisions

(Simons & Peterson, 2000). In contrast to relationship conflict, task conflict is not significantly associated with team performance. It will depend on team learning and performance orientation. However, teams that experience task conflict tend to make better decisions than those that do not, because they achieve a greater cognitive understanding of the focal issue. The drawback is that the quality of team member interaction deteriorates as debates over task issues threaten group harmony.

Another form of social structure relevant for teams is different forms of *genre rules*. Genre rules are the social structures that guide the form and substance of communication (Orlikowski & Yates, 1994; Yates & Orlikowski, 1992). Genre rules develop over time from repeated use of a communication tool and are typically based on the commonly occurring habitual patterns of use that emerge. Genre rules are influenced by the capabilities of the tool itself and usually emerge from repeated use, although they can develop through formal guidance (Thomas & Bostrom, 2010b; Yates et al., 1999). Genre rules are usually enacted without a conscious decision (they are akin to a habit), unlike the deliberate appropriation processes that occur during the adoption of new technologies. Although they are not developed and implemented by organization and management, they still become guiding for team work. In a paper from 2014, Bartlet and Denis examine how the social structures in the form of genre rules that emerge around different communication tools can be as important as the tools themselves in influencing performance. An experimental study of genre rules for instant messenger and discussion forums showed that in habitual-use situations these tools triggered different genre rules with different behaviors, which in turn resulted in significantly different decision quality. The teams in the study enacted different genre rules for the two different tools, which led to significant differences in non-task discussion, decision

quality, and enjoyment. When the enactment of the habitual-genre rules was interrupted by heightened time pressure, these differences disappeared; the teams enacted similar genre rules for both tools and, thus, their behavior, decision quality, and enjoyment were not significantly different. Therefore, the differences in outcomes between the normal usages of the two tools was not due to the tools themselves, but rather the genre rules that users enacted.

One obvious structural group factor that should influence learning is *diversity*. Diversity, in theory, should be positive for learning, since it implicitly means having access to more knowledge, experience, and perspectives. Studies have shown that teams, and organizations, whose members are heterogeneous in meaningful ways, for example, in skill set, education, work experiences, perspectives on a problem, cultural orientation, and so forth, have a higher potential for innovation than teams whose members are homogeneous. According to Nelson (2014), diverse teams, as well as organizations, are more effective; they produce better financial results and better results in innovation. Companies in the top quartile of number of women on the executive committee (years 2007–2009) had 41% greater return on equity and 56% greater earnings before interest and taxes, than companies with no women on the executive committee (Desvaux, Devillard-Hoellinger, & Sancier-Sultan, 2010). These results are argued to show that having a diverse organization is a business imperative. However, it seems to be only under certain conditions that diversity becomes a strength. In a study of diversity as a factor of team performance, Homan et al. (2008) examined how the performance of diverse teams is affected by member openness to experience (compare with need-for-cognition in the study by Kearney, Gebert, & Voelpel, 2009) and the extent to which team reward structure emphasizes intragroup differences. Fifty-eight

heterogeneous four-person teams engaged in an interactive task. Teams in which reward structure converged with diversity (i.e., “fault-line” teams) performed more poorly than teams in which reward structure cut across differences between group members or pointed to a “superordinate identity.” High openness to experience positively influenced teams in which differences were salient but not teams with a superordinate identity. Information elaboration mediated this effect. As described above, Gibson & Vermeulen (2003) in their study also confirmed that subgroups and subgroup strength influence the relationship between diversity and performance.

A final organizational factor that is noteworthy and relates to diversity can be found in a study of collective intelligence and creativity (Nelson, 2014 citing Woolley et al., 2010). In this study, researchers gave subjects aged 18 to 60 standard intelligence tests and assigned them randomly to teams. Each team of three to five people was asked to complete several tasks, including brainstorming, decision-making, and visual puzzles, and to solve one complex team problem. Teams were given intelligence scores based on their performance. One predictor of team collective intelligence turned out to be the number of women on the team. This was a surprise result to the researchers. With more investigation, it was found that the difference was having the social skills that made it possible to use the contributions of all the team members, and these correlate more with women than with men. (See more on this study below, Woolley et al., 2010).

STIMULATING LEARNING PROCESSES AT GROUP LEVEL

How then, can organizations stimulate learning at group or micro-system level? An important aspect of learning is that it cannot just be ordered or “pushed” on teams. Instead it is the spontaneous and self-regulated learning that originates within micro-systems, from its members, that are important to organizations.

First, to guide development of managed interventions to stimulate learning, we can start looking at a conceptual model developed by Prati et al. (2003) to bring together theory and research on emotional intelligence, leadership, team process, and outcomes. According to Prati et al., emotional intelligence reflects the ability to read and understand others in social contexts, to detect the nuances of emotional reactions, and to utilize such knowledge to influence others through emotional regulation and control. As such, it represents a critically important competency for creating learning processes at team level. Their propositions in relation to emotional intelligence and team performance are (Prati et al., 2003):

- 1: The emotionally intelligent team leader will induce collective motivation in team members.
- 2: The emotionally intelligent team leader uses charismatic authority and transformational influence in order to improve team performance.
- 3: The emotionally intelligent team leader and team member is aware of and adheres to his and her role in the team.
- 4: Emotional intelligence will moderate the effect of specific personality traits on leader and team member interaction.
- 5: The level of work-team cohesion is dependent upon the degree of team members’ emotional intelligence.

6a: The level of team trust is dependent upon the degree of team members' emotional intelligence.

6b: Team trust facilitates constructive and collaborative group interactions, which positively affects team performance.

7: The emotionally intelligent team offers an environment conducive to creative expression.

8: Team decision-making ability is dependent upon the degree of team members' emotional intelligence.

9a: Team members with a high degree of emotional intelligence will facilitate a negative influence on social loafing problems.

9b: Team members with a low degree of emotional intelligence will negatively affect team performance by engaging in social loafing.

10: The emotional intelligence level of team members is positively related to team performance.

According to Prati et al. (2003), the evaluation of these claims should advance the emotional intelligence literature. If emotional intelligence can be increased through training, it could provide a way forward toward the achievement of better organizational performance by enhancing organizational member interactions. The Barczak et al. (2010) study, though based on student teams, offers several potential implications for managers. First, the finding that emotional intelligence is a predictor of team trust suggests that managers need to determine the emotional intelligence of each subordinate. Once this is accomplished, activities such as training in emotional intelligence could be undertaken to improve individual and team capabilities. Also, assessments of emotional intelligence could be used with job candidates, particularly those applying for positions which require substantial teamwork.

Second, the impact of trust on a collaborative culture, and cognitive trust on creativity, reinforces that trust is a critical element of teams that managers need to monitor. To build and sustain trust, managers need to create situations for both formal and informal communication among team members. For example, meetings and training at the beginning of a project can help team members get to know each other and start to build relationships that can ultimately lead to a creative approach to the task. The positive impact of cognitive trust on the relationship between a team's collaborative culture and creativity also suggests that managers need to recognize the importance of team members' perceptions of the reliability and competence of their colleagues. To aid these perceptions, it is obviously most useful to hire functionally competent individuals. However, functional competence is not sufficient for cognitive trust. Individuals also need to possess skills such as working with others, being reliable, doing whatever is needed to accomplish the task, and being flexible.

At an organizational level, results from the study of learning culture (Yoon, Song, Lim, & Joo, 2010) found that a learning-oriented organizational culture directly impacted the level of team creativity and the teams' knowledge creation practices, and each construct made a direct impact on team performance. Team creativity also made a direct positive impact on the teams' collaborative knowledge creation practices. These findings also support the importance of explicit team development and facilitation for team performance improvement.

Lee, Park, & Lee's study from 2013 finds that cognitive, intellectually competent leaders can achieve short-term successes, but for longer term projects, attention needs to be paid to the formation and nurturing of team social capital. Internally accumulated know-hows and efficiencies of shared language based on stronger

trust among team members become more critical than cognitive leadership. It is, therefore, necessary to find institutional and technical ways to build team social capital as part of leadership development supporting the selection and cultivation of project managers with balanced skills and abilities to promote interactions between members and the accumulation of knowledge at the same time.

To become high performing, teams need to make use of their different skills and reflect upon their collective actions, thereby combining knowledge that could lead to value-adding activities for the company. In a collaborative research approach, Mulec and Roth (2005) used eight months of coaching, employing several inquiry methods. The results indicate that coaching interventions have a positive effect on team performance, both from an efficiency perspective as well as from creativity and climate perspectives. The results of the questionnaires, observations, and interviews displayed a uniform picture of the coaching resulting in a stronger and more supportive team environment. Team spirit was expressed in various ways as having become stronger, with a shared value base. Coaching was effective in both the behavioral and structural areas of the teams' work. The coaching focused on the role of the team and the individuals, the goal of the team (both business goal and team goal), and the context in which the teams were acting. This holistic approach gave the teams a better understanding of the individual's role in the teams, the teams' role within the organization, as well as more structured working processes and goal descriptions. Also, there was an indication that individuals brought their newly learned skills to their individual teams and thus influenced a wider system than just the teams that were subjected to coaching.

Looking at more specific factors relating to the learning process, Kearney, Gebert, and Voelpel (2009) argue that need-for-cognition is a cognitive

factor that can be worked with and stimulated. Possible ways in which leaders can motivate those low in need-for-cognition includes linking the information to be processed, or the intended outcome of the team task, to some aspect of a person's self-concept and thereby making it highly personally relevant and emotionally appealing. Other means should be to describe a compelling common vision, intellectual stimulation, and fostering collective team identification. Also, leaders could enhance information-processing motivation by explicating the value of diverse views and by increasing accountability for decisions and outcomes. Moreover, by promoting a climate of psychological safety and the right combination of task and goal interdependence, leaders can help develop a cooperative climate that supports both elaboration of task-relevant information and the collective team identification. Both variables help to prevent team members from feeling threatened or annoyed by diversity.

Working with team goal orientation (Gong, Kim, Lee, and Zhu, 2013), managers may find it useful to foster team learning goals. This can be done by serving as role models and by rewarding learning. Managers may also encourage the team performance approach goal, which is indirectly related to creativity via an increased information exchange within a team. It should be pointed out that a high team learning goal does not necessarily benefit efficiency-based performance. Secondly, managers may foster team information exchange. An open exchange of information in collaborative efforts is critical to team creativity, and both team learning goal and team performance approach goal are positively related to information exchange. Managers may provide institutionalized platforms or channels for exchanging ideas, perspectives, and knowledge. These factors can help to increase individual creativity, which may, in turn, foster the

supportive climate for creativity that is beneficial to team creativity.

The experimental groups of the Okhuysen (2001) study illustrated that the use of a formal intervention and inter-member familiarity resulted in a higher number of group self-interruptions and a greater concentration of attention switches into clusters. Within such clusters of attention switches, members consider multiple areas of the group process and then execute changes in their interaction. The changes in the groups that occur during these clusters are in response to their members' increasing understanding of the task. These changes affect the number of critical facts identified in the problem diagnosis. Thus, such clusters, acting as interruptions to the task, lead to greater flexibility and greater opportunities for adaptation, which, in turn, leads to higher performance. Overall, the results of this research show that formal interventions and familiarity operate in a similar manner, by organizing the clustering activity in groups. Members use these attention switches to interrupt the task work and open windows of opportunity for change. A formal intervention works to provide legitimacy to such changes and experimentation. For example, stranger groups using a formal intervention showed a greater number of attention switches to social interaction. Given the potential benefits from increased social interaction in a group (such as releases in tension, reduction of inhibition, and positive expression of conflict), this enabling role of formal interventions becomes important. The research also showed a link between the development of roles in a group and clustering activities. The research indicates that members who are effective in focusing the attention of a group (on the requirements of the formal intervention) are likely to be seen as leaders. The difficulties that familiar groups faced using formal intervention is illustrated in the findings about roles. Familiar groups' members could identify persons in roles as a joker and/or a leader, but this

was not the case once a formal intervention was imposed. There appear to be two reasons for the confusion that the interventions caused. In particular, "the clown" did not feel free to exercise the role prerogative of joking that might initiate many of the interruptions that leaders can take advantage of to refocus the energies of their groups. In addition, when more than one group member initiated clusters due to formal intervention, this could be interpreted as leader-like behavior, and therefore confused the ownership of the role of leader.

To avoid information filters and diffused learning, Oorschot et al. (2013) suggest changed methodology in project governance. It is known that people have difficulty in understanding complex dynamic settings (Cronin et al., 2009; Sterman, 1989) and that they often respond to those settings by simplifying decision processes or cognitive representations (Bourgeois, McAllister, & Mitchell, 1978; Sherman & Keller, 2011), leading to poor performance. Previous research has also shown that most individuals lack the capacity to deal with dynamic complexity (Gonzalez, 2005; March, 2006; Van de Ven, 1986). However, this capacity can be improved by providing participants with cognitive feedback (i.e., information about relations in the decision environment, about relations perceived by the person in that environment, and about relations between the environment and that person's perception of it). Sengupta and AbdelHamid (1993) demonstrated that cognitive feedback can improve performance in dynamic decision-making tasks. Gonzalez (2005) argued that cognitive "feedforward" (i.e., information that helps decision-makers to analyze the effects of possible future decisions) improves performance when dynamic decision-making tasks are performed in real time. Mapping causal relationships also helps decision-makers because it forces them to be explicit—not only about relevant

variables but also about their dynamic properties (Ramanujam & Goodman, 2003). Causal maps provide feedforward-based heuristics for managing projects in a complex dynamic environment.

The findings of Wong (2004) reinforce our understanding that different types of group learning have different impacts on group performance. Distal learning was positively associated with group innovativeness, and local learning was positively associated with group efficiency, suggesting that there are performance trade-offs to selecting one type of group learning over the other.

The study of Huang (2012) provides practical insights into conflicts that can help structuring teams and stimulating their performance. First, “relationship conflict” was always negatively related to team performance. Relationship conflict arouses anger and anxiety causing mutual distrust. Since the locus of the conflict is not the task, completion of work is obstructed. Hence, team managers should try to reduce the frequency and intensity of “relationship conflict.” Second, team members’ goal orientations have a significant influence on team performance. This offers practical insight for recruiting members. There is a positive relationship between task conflict and performance in teams with high learning orientation (or a low performance orientation). Innovative, complex, or uncertain tasks may require teams to create multiple ideas to arrive at a deep understanding and high-quality decisions. In these circumstances, team manager may use “goal orientation disposition” as a criterion for selecting team members. Some researchers propose various interventions to trigger goal orientation states, goal orientation mindsets, and behavioral manifestations (Kozlowski and Bell, 2006; Chen and Mathieu, 2008). Managers can frame their team members’ tasks and discussion toward learning rather than performance goals. Finally, in

collectivistic cultures, people tend to be concerned about the evaluations of others. In such contexts, it is imperative for managers to guide team members in perceiving different opinion or criticism as valuable diagnostic information rather than denial of their abilities. Thus, helping team members to share divergent opinions openly is useful, since task conflicts can benefit performance.

Because of an increasingly diverse workforce, work groups are inevitably composed of members with different demographic backgrounds, values, expertise, and perspectives. As previous research on the effects of diversity in teams has shown inconsistent results, the Homan et al. study (2008) set out to broaden our understanding of diversity and how that relates to team learning. The positive effects of diversity are assumed to be caused by information/decision-making processes. The negative effects are assumed to result from disruptive social categorization processes (Williams & O'Reilly, 1998). However, these perspectives are not able to predict when positive or negative effects of diversity will occur. That is, given a certain level of diversity, it is difficult to forecast, based on these theories, what the performance of a team will be. Perhaps the most compelling finding of the Homan et al. study was that in both the highest- and lowest-performing teams, diversity was salient. The outcomes of diversity are contingent upon the salience of the diversity, as well as upon how people feel about diversity. *First*, their findings point to the importance of diversity salience. Comparing three conditions of salience, they showed that within sex-diverse teams, increasing the salience of sex-based subgroups by aligning sex with reward structure leads to lower levels of performance, whereas cross-cutting sex with reward structure or providing a superordinate identity leads to higher levels of performance. These findings represent an important qualification of the social categorization perspective because they indicate that teams with similar levels of diversity do not necessarily

experience similar social categorization processes and exhibit similar performance. It suggests that the relation between diversity and performance is more complex than is assumed in the social categorization perspective, as diversity does not necessarily hamper group processes and consequential group performance. Their findings also address the information/decision-making perspective, according to which diversity stimulates the use of information and thereby enhances performance. The present study indicates that such positive effects of diversity are likely to occur when the salience of subgroups within a team is reduced, but not when subgroup salience is reinforced. *Second*, they show that there are differences in how teams experience their diversity based on the openness within the team. The study shows that diverse teams that score high on openness to experience perform better than diverse teams that score low on this characteristic. When differences within a team are salient, openness to experience helps teams to capitalize upon their differences. This suggests that people's ideas about diversity should be considered when examining diversity effects. *Third*, the study qualifies and extends the similarity/attribution paradigm, superordinate identity models, and fault-line theory. Whereas the similarity/attribution paradigm leads to the prediction that people will be more attracted to similar than to dissimilar others, their results show that there are individual differences in people's reactions to dissimilar others. One can, therefore, not simply predict that within diverse teams people will be more attracted to their in-group than to an out-group; rather, such attraction depends on people's openness to experience. The findings also show that installing a superordinate identity can help to overcome some of the negative consequences of diversity, even when groups score low on openness to experience. *Finally*, regarding fault-line theory, the results indicate diversity fault lines need not disrupt team processes, if team members score high on

openness to experience. In summary, these findings suggest several possible diversity-management strategies. *First*, selecting team members who score high on openness to experience might help teams make use of the value in diversity. *Second*, when diverse teams contain members low in openness, a solution would be to advocate pro-diversity beliefs, to stimulate information elaboration and team performance. *Thirdly*, another practical solution for managing diverse teams low in openness to experience would be to install a superordinate identity to decrease diversity salience and prevent subgroup categorization. One way in which management could accomplish this would be to use reward structures that emphasize a team's superordinate identity. *Finally*, in teams high in openness, reward structures may be used to create a cross-categorized identity that highlights diversity but reduces the salience of subgroups. Although a strong focus on superordinate identity can result in better performance, as compared to a fault-line group it might also decrease the positive effects of openness to experience.

A final study, with results on what might be the most powerful intervention for team-learning, is that of Tannenbaum & Cerasoli (2012). Debriefs (or "after-action reviews") are increasingly used in training and work environments as a means of learning from experience. The researchers sought to unify a fragmented literature and assess the efficacy of debriefs with a quantitative review. Used by the U.S. Army to improve performance for decades, and increasingly in medical, aviation, and other communities, debriefs systematize reflection, discussion, and goal setting to promote experiential learning. Unfortunately, research and theory on debriefing has been spread across diverse disciplines, so it has been difficult to definitively ascertain debriefing effectiveness and how to enhance its effectiveness. Tannenbaum & Cerasoli conducted an extensive quantitative meta-analysis across a diverse body of published

and unpublished research on team- and individual-level debriefs. Findings from 46 samples ($N = 2,136$) indicate that on average, debriefs improve effectiveness over a control group by approximately 25% ($d = .67$). Average effect sizes were similar for teams and individuals, across simulated and real settings, for within- or between-group control designs, and for medical and nonmedical samples. Meta-analytic methods revealed a bolstering effect of alignment and the potential impact of facilitation and structure. The researchers' conclusion was that organizations can improve individual and team performance by approximately 20% to 25% by using properly conducted debriefs. According to them, debriefs are a relatively inexpensive and quick intervention for enhancing performance. Their results lend support for continued and expanded use of debriefing in training and *in situ*. To gain maximum results, it is important to ensure alignment between participants, focus and intent, and level of measurement.

2. FACTORS FOR INDIVIDUAL LEARNING IN GROUPS

Essential in collective learning are the simultaneous individual learning processes. The collective learning process can be seen as the result of or sum of individual learning activities. As Reagan et al. (2005) argue, there is a relationship between individual learning (outmost the cognitive processes of the individual brain) and organizational learning. To illuminate factors responsible for the variation in collective learning rates, the learning ability of the individual is an important point of departure, and in this section, we focus on factors related to individual learning in group contexts.

PSYCHOLOGICAL AND COGNITIVE FACTORS RELATED TO INDIVIDUAL LEARNING

Bonabeau discusses this perspective in an article from 2009, where his point is how we need to consider limitations in the human brain—different forms of bias—as we work with organizational collective intelligence.

The human brain is a magnificent instrument that has evolved over thousands of years to enable us to prosper in an impressive range of conditions. But it is wired to avoid complexity (not embrace it) and to respond quickly to ensure survival (not explore numerous options). In other words, our evolved decision heuristics have certain limitations, which have been studied extensively and documented over the last few decades, particularly by researchers in the field of behavioral economics. Indeed, the ways in which our brains are biased may be well suited to the environment of our ancestors, when a fast decision was often better than no decision at all. But the hypercompetitive and fast-paced world of business today requires short response times and more accurate responses and more exploration of potential opportunities. (Bonabeau, 2009).

According to Bonabeau, decision-making can be broken into two tasks: the generation of potential solutions and the evaluation of them. Each of these tasks can be negatively influenced by numerous human biases. Examples of *biases in generation of solutions* are: (1) self-serving bias (seek to confirm own assumptions), (2) social interference (influenced by others), (3) availability bias (satisfied with an easy solution), (4) self-confidence bias (believes prematurely to have found the solution), (5) anchoring (explores in the vicinity of an anchor), (6) belief perseverance (keeps believing despite contrary evidence), and (7) stimulation (“only knows a solution when seeing it”). Examples

of biases in evaluation of solutions are: (1) linearity bias (seeks simple cause-effect relationship), (2) local versus global (confuses local and global effects), (3) statistical bias (avoids statistical analysis), (4) pattern obsession (sees patterns when none are present), (5) framing (influence by presentation of solution), (6) hyperbolic discounting (dominated by short-term effect), and (7) endowment bias (has aversion to risk or loss).

In a recent study relating to biases of the human brain, Minas et al. (2014) use NeuroIS⁴ to study *information processing biases* in virtual teams. Virtual teams are increasingly common in today's organizations, yet they often make poor decisions. Teams that interact using text-based collaboration technology typically exchange more information than when they perform the same task face-to-face, but past results suggest that team members are more likely to ignore information they receive from others. Collaboration technology makes unique demands on individual cognitive resources, and this may change how individual team members process information in virtual settings compared to face-to-face settings. In the study, Minas et al. use NeuroIS applications such as electroencephalography (EEG), electrodermal activity (EDA), and facial electromyography (EMG) to investigate how team members process information received from text-based collaboration during a team decision-making process. Their findings show that information that challenges an individual's pre-discussion decision preference is processed similarly to irrelevant information, while information that supports an individual's pre-discussion decision preference is processed more thoroughly. These results present

neurological evidence for the underlying processes of confirmation bias in information processing during online team discussions using text-based information.

In addition to biases like above, research also shows that group members often fail to exchange their uniquely held information. In a study from 2003, Kim relates this form of learning (or lack of learning) to group members' *beliefs about coworkers*. Kim (1997) looked at the effect of this on group discussions and performance and found that groups in which members had previously worked together on a similar task displayed a larger discussion bias and achieved lower task performance than groups with no prior experience with coworkers or the task. One explanation for this effect is a sort of collective "curse of knowledge," in this case, referring to people's tendency to overestimate the ability of others to solve a problem accurately. Kim suggested that members of experienced groups may have exhibited a larger discussion bias and achieved lower performance because their greater familiarity with both the task and team may have made them more susceptible to believe that their partners already were aware of their privately held information and, thus, led them to exert less effort to communicate it than members of inexperienced groups. A more thorough explanation for the findings is that experience may shape a range of beliefs about coworkers (e.g., due to increased familiarity with the task and/or team, members' schemas about how relationships and/or capabilities should develop over time, and so on) and that each of these beliefs can affect the sharing of information in groups. This notion is based on research in which perceptions of high coworker competence and motivation were found to lower

⁴ NeuroIS is the application of cognitive neuroscience methods in the information systems (IS) field, for example EEG, EDA, facial EMG.

member efforts and collective performance (Williams and Karau, 1991) as well as on the potential implications of such perceptions for group coordination and discussion (Wittenbaum et al., 1998, 1999). In the 2003 study, Kim found that although perceptions of 'higher achievement motivation' in coworkers lowered performance when task information was partially shared, the same perceptions also raised performance when task information was fully shared. Two beliefs were considered: (1) perceptions of coworker task competence, and (2) perceptions of coworkers' achievement motivation. The evidence from this study suggests that beliefs about coworkers can exert important effects on group discussion and performance. The study suggests that the discussion behaviors in general, and two behaviors in particular (i.e., "the frequency with which group members contributed justifications" and "confirmed partner statements"), completely mediated the relationship between the "perceived motivation X information distribution" and "performance" offers interesting explanations. These behaviors may have enhanced teamwork and, thus, fostered interactions that allowed group members to work more effectively. This interpretation is not only consistent with the notion that coworker perceptions can influence social loafing versus social compensation in groups (Williams and Karau, 1991), but also supports the notion that the extent to which members repeat and validate each other's ideas can affect the nature of group decisions (Brauer et al., 1995).

Continuing on the relationship between cognition and the use of information systems, Engel et al. (2014) present an interesting study of how social perceptiveness matters also in virtual groups. In research with face-to-face groups, Woolley et al. (2010) found that a measure of general group effectiveness (called c-factor) predicted a group's performance on a wide range of tasks. The same research also found that collective intelligence was correlated with the individual group members'

ability to reason about the mental states of others (social perceptiveness, see Woolley et al., 2014). Since this ability was measured by a test that requires participants to "read" the mental states of others from looking at their eyes (the "Reading the Mind in the Eyes" test), it is uncertain whether the same results would emerge in online groups, where these visual cues are not available. However, in their study, Engel et al. find that: (1) a collective intelligence factor characterizes group performance approximately as well for online groups as for face-to-face groups; and (2) surprisingly, the social perceptiveness measure (RME-test) is equally predictive of collective intelligence in both face-to-face and online groups, even though the online groups communicate only via text and never see each other at all. This provides strong evidence that social perceptiveness is just as important to group performance in online environments with limited nonverbal cues as they are face-to-face. It also suggests that the Reading the Mind in the Eyes test measures a deeper, domain-independent aspect of social reasoning, not merely the ability to recognize facial expressions of mental states.

To conclude this section, its apparent that the human brain suffers from a number of biases in knowledge processes. Some just due to how our brain works, others related to who we have around us and how we relate to them. But this also makes it apparent that awareness of this and working with preventing or compensating factors should be a way of developing organizational knowledge work at micro-system level.

PROCESS AND ORGANIZATIONAL FACTORS IN INDIVIDUAL LEARNING

Learning by doing represents an important mechanism through which organizations prosper. Some firms, however, learn from their experience

at a dramatic rate, while other firms exhibit very little learning at all (Reagans et al., 2005). Three factors of *individual experience* have been identified that affect the rate at which firms learn: (a) the proficiency of individual workers, (b) the ability of firm members to leverage knowledge accumulated by others, and (c) the capacity for coordinated activity inside the organization. Each factor varies with a particular kind of experience. An increase in cumulative individual experience increases individual proficiency. An increase in cumulative organizational experience provides individuals with the opportunity to benefit from knowledge accumulated by others. An increase in cumulative experience working together promotes more effective coordination and teamwork. To gain insight into factors responsible for the learning curve, the Reagans et al. study examined the contribution of each kind of experience to performance, while controlling for the impact of the other two. The study context was a teaching hospital. The task was a “total joint replacement procedure,” and the performance metric was procedure completion time. They found that each kind of experience made a distinct contribution to team performance. The effect of individual experience on team performance had an inverted U-shape. At low levels of individual experience, increasing individual experience hurt procedure completion times. After approximately five procedures, however, continued increases in individual experience were associated with decreases in procedure completion time. The researchers believe that the initial effect of experience on completion time was a form of negative transfer: Individuals inappropriately applied what they learned working with one set of colleagues to a different set. As individuals gain experience, they learn about the task, and they learn how to apply what they learn working with one set of colleagues to another set. The effect of their experience on performance then becomes beneficial. In the team context, individuals not only

learned the task, but they also learned about other people performing the task. Being productive requires an appreciation for each kind of knowledge and the situations in which each kind is valuable.

The results advance our understanding of the factors responsible for effective teamwork. Experience working together was a significant predictor of team performance. Two basic mechanisms were identified through which team experience was beneficial to the organizational learning outcomes. (1) Members of teams with considerable experience working together have more accurate and more sophisticated knowledge of who knows what on the team than their less-experienced counterparts. This knowledge enables experienced teams to match members with the tasks for which they are most qualified and enables members to know to whom to go for advice on the team. (2) Experience working together also improves coordination by enabling members to anticipate each other’s actions and by developing special languages and shorthand ways of communicating. Members of teams with considerable experience working together are also more likely to trust each other than members lacking such experience.

A more specific tool for addressing learning, *after-action-reviews*, is also useful to mitigate some of the learning biases described in this section. For decades, the U.S. military has deployed after-action reviews (or “debriefs”) designed to improve learning and performance (Tannenbaum & Cerasoli, 2012). Debriefs lead individuals or teams through a series of questions that allow participants to reflect on a recent experience, construct their own meaning from their actions, and uncover lessons learned in a non-punitive environment. Debriefs have become a common tool for supporting experiential learning in military settings and are becoming more common in other sectors as well. They are used in training settings

(e.g., after a simulation exercise) as well as in situ (e.g., after a work experience). Debriefs are a potentially powerful yet simple tool to improve the effectiveness of teams and individuals, but research and theory have been scattered across multiple disciplines. However, in a meta-analysis Tannenbaum & Cerasoli indicates that on average, debriefs improve performance by approximately 25%. Even excluding the three largest effect sizes yields a conservative average improvement of 21%. Pragmatically, an improvement of 20% or more is quite encouraging for an inexpensive intervention that requires little time to conduct (the average debrief studied lasted approximately 18 min). Moreover, debriefs appeared to work equally well for teams as they did for individuals. Their findings indicate that aligning participants, intent, and measurement yield the greatest effects. When the goal is to improve team effectiveness, it makes sense to conduct debriefs with teams, to focus on improving the team, and to measure the performance of the team as a whole. In fact, on average, team debriefs that were conducted and studied in that manner showed an average effect size of 38%, including two of the three largest effect sizes in the meta-analysis. Similarly, when the goal is to improve individual effectiveness, focusing on improving the individual's performance (rather than the team's performance) is more effective. However, noteworthy is that although alignment is clearly optimal, even "misaligned" debriefs demonstrated a reasonable level of efficacy, suggesting a broad range of acceptable applications.

STIMULATING LEARNING ON INDIVIDUAL LEVEL

In this section the researchers' ideas on implications and interventions are summarized. For example, Bonabeau (2009) argues for tools he calls *outreach*, *additive aggregation*, and *self-organization* that can be used for mitigating biases

in collective intelligence caused by the human brain. *Outreach:* When collecting ideas (generation) or assessing them (evaluation) a company might want to tap into people or groups that have not traditionally been included. It might, for instance, want to reach across hierarchical or functional barriers inside the organization, or it could even desire to obtain help from the outside. The value of outreach is in numbers: broadening the number of individuals who are generating or evaluating solutions. The development of open-source software is perhaps the best example of the power of sheer numbers. "With enough eyeballs, all bugs are shallow" is the commonly quoted expression, which means that, with enough people working on a project, they will uncover every mistake. The underlying philosophy here is that there are people out there who can help you and, moreover, those individuals are not necessarily where you might expect them to be. *Additive aggregation:* Companies can collect information from myriad sources and then perform averaging. The process can be used to aggregate data from traditional decision groups, or it can also be combined with outreach to include information from a broader set of people. Here, the whole is, by definition, equal to the sum of its parts (or some average of it). The simplest example involves the direct application of the law of large numbers—for example, asking a crowd to estimate the number of jelly beans in a jar and then taking an average of all the responses. The key is to maintain the right balance between diversity and expertise. *Self-organization* is the mechanisms that enable interactions among group members to become "a whole" being larger than the sum of its parts. However, there is a danger: If the interaction mechanisms are not designed properly, the whole can end up being much less than the sum of its parts. Groupthink is but one example of the downside of self-organization. Finally, Bonabeau makes a general observation. Collective intelligence tends to be most effective in correcting

individual biases in the overall task area of generation. He speculates that we, as individuals, are far weaker explorers than evaluators, and that, for all the flaws in our heuristics, we are pretty good at detecting patterns. Thus, when tapping a collective, companies are now more likely to obtain greater value from idea generation than from idea evaluation.

Regarding the Minas et al. (2014) study, their findings illustrate the importance of considering how information systems affect individual cognition. It suggests that a primary cause of poor decision-making in virtual teams is confirmation bias rather than information overload. Immediate implications include designing collaboration systems that mitigate an individual's confirmation bias, in addition to focusing on issues of group information exchange. Confirmation bias is inherently an individual process, not a team process. Much past team research focused on a social psychology-based framework of process gains and process losses that collaboration can introduce into the teamwork process. Such social psychological factors remain important, but there is a need to place a greater emphasis on cognitive psychology and the ways in which individual cognition influences teamwork. An example is Kray and Galinsky (2003), where they show that a team-building exercise can be used to induce counterfactual information search and processing—the search for and use of information that challenges a team member's initial pre-discussion preferences. By introducing such a counterfactual priming procedure, it may be possible to mitigate some of the confirmation bias observed. Likewise, routinely summarizing known facts and organizing them as supporting or

challenging specific alternatives may avoid overlooking preference-challenging information.

The Kim (2003) study of coworkers' perceptions of each other also suggests that it may be useful to investigate how various discussion behaviors may provide ways of information sharing in groups. The purpose of the study was to investigate how beliefs about coworkers affected group information sharing and performance. It discovered that the discussion behaviors in general, and two behaviors in particular: the frequency with which group members contributed justifications and confirmed partner statements⁵, completely mediated the relationship between perceptions of motivation and performance (perceptions of motivation X information distribution action and performance). This supports the notion that the extent to which members repeat and validate each other's ideas can affect the nature of group decisions (Brauer et al., 1995). This approach of examining group processes may prove beneficial by allowing us to move beyond simple measures of the extent to which information is shared to provide insight into the way it is used. The study highlights the importance of considering more thoroughly the social-psychological processes operating in groups.

The Engel et al. study (2014) show that the relationship between team cognitive ability and performance vary with the way that cognitive ability is represented in the team and the type of task the team is performing. In particular, the performance of teams working on a task that requires a high degree of cooperation and

⁵ This could be relevant measures of level of communicative dynamics

communication is most influenced by the member with the lowest cognitive ability because that person tends to slow the rest of the group. In contrast, on tasks for which the optimal strategy is to select the best member (e.g., running a race, or answering a factual question), the cognitive ability of the highest scoring member tends to predict performance. Finally, more complex, multifaceted tasks that require each member of the team to perform a subtask and then combine inputs into a team product are most influenced by the average ability of team members. Higher average cognitive ability is associated with greater propensity to adapt to a changing environment, as well as to learn from new information discovered during work. It is also an interesting question whether the degree of social perceptiveness, as measured by RME or otherwise, can be altered by training or experience. It remains an open question, but recent studies (Kidd & Castano, 2013) suggest that theory of mind abilities as measured by RME can be, at least temporarily, improved by, for example, reading literary fiction, which implies a new and interesting avenue of research for improving group performance. In summary, the results of this study provide strong empirical support for the conclusion that even the collaboration of teams working online can be characterized by a single collective intelligence factor, and that theory of mind abilities are just as important to group effectiveness in these online environments where many kinds of nonverbal communication are not possible. In other words, it appears that the Reading the Mind in the Eyes test does not just measure the ability to read emotions in eyes but also the ability to “read between the lines” of text-based online interactions.

In the Reagans et al. (2005) study, the three factors of *individual experience* that were identified as affecting the rate at which firms learn (the proficiency of individual workers, the ability of

firm members to leverage knowledge accumulated by others, and the capacity for coordinated activity inside the organization) all represents a distinct kind of knowledge. However, according to the authors, the different kinds of knowledge can substitute for each other. For example, the goal of the program is to train competent surgeons. Turnover is expected. However, turnover in the program reduces the level of individual and team experience inside the organization. The decline in knowledge can be expected to hurt performance. The results indicate, however, that the loss of knowledge due to this turnover can be compensated for in part by how future teams are constructed. Teams should contain at least three individuals, two individuals who are experienced and have experience working with each other and a third person who lacks experience. Such a team would provide an attractive training ground for an inexperienced resident or fellow. It provides the individual with the opportunity to gain experience, but his or her lack of experience would not significantly hurt the level of individual experience and experience working together on the team. The impact on procedure completion times could be minimized. Even though this research is about performance improvements in hospitals, other types of organizations are structured similarly to teaching hospitals in that individuals work on teams whose memberships change over time and are nested in larger organizations. However, it is important to note that the studied environment represents a situation with fairly immediate feedback on team performance (joint replacements). This makes it easier for teams and individuals to learn and adapt.

3. KNOWLEDGE SYSTEMS AS GROUP PATTERNS

COLLECTIVE INTELLIGENCE—A PROCESS OF SELF-ORGANIZATION

In the last few decades, a new scientific paradigm for organizations has slowly been emerging: complexity (Liang, 2007; Heylighen, 2012). This paradigm departs from traditional organizational paradigms based on reductionism and determinism by focusing on the non-linear interactions between the components of a complex system. Central in this is the phenomenon of *self-organization*. Collective intelligence could be seen as the result of such processes of self-organization, putting the emphasis not only on learning but also on the enactment of a team as a collective system. Due to their social interactions, and establishing of relations, any group will experience a form of self-organization. Individuals come to the table with different backgrounds, habits, ideas, cultures, perspectives, and even languages. To be able to communicate at all, they first need to agree on a common set of terms and what those terms mean. Heylighen (2012) calls this the emergence of *linguistic conventions*, the first step toward a shared representation. They need to agree about basic assumptions, such as what the situation is, what can be done about it, and what should be done about it. Finally, they will need to agree on who will do what and when. If successful, this sequence of agreements will lead to a coordinated form of action, where the different members of the group contribute in an efficient way to a collective solution to whatever their problem was. If this process were directed by a single individual (say, the group leader) who imposes a consensus view on the others, then that view would ultimately not

be more powerful than the view of the leading individual. In other words, the collective would in the end not be able to be more intelligent than its leader.

True self-organization, however, happens in a distributed or decentralized manner: The different members of the group all contribute to the emerging organization, and no one is in control. This makes the process complex and intrinsically unpredictable, as tiny differences in the initial state (such as who speaks first, or which word is initially used to designate an item) may lead to very different outcomes. That is why such a process of group discussion and emergent interaction patterns needs to be understood with the conceptual tools of complexity science. Processes in complex systems are usually non-linear, their effects are not proportional to their causes. The basic principles for the development of a complex system are that when the effects are larger than the causes we may say that there is an amplification or positive feedback; initially, small perturbations reinforce themselves to become ever more intense. (Examples are the spread of a disease, chain reaction that leads to a nuclear explosion, and so forth.) When the effects are smaller than the causes, there is a dampening or negative feedback. Interactions with positive feedback are very sensitive to their initial conditions; a change in that condition may be so small that it is intrinsically undetectable, yet results in a drastically altered outcome (this is what has been called the *butterfly effect*). The non-observability of the initial perturbations means that the outcome is in principle unpredictable, even if the dynamics of the system were perfectly deterministic. Positive feedback will amplify small, random fluctuations into wild, unpredictable swings, making the overall behavior of the system chaotic.

The concept of self-organization is becoming increasingly popular in various branches of science and technology. Although there is no generally accepted definition, a self-organizing system may be characterized by global, coordinated activity arising spontaneously from local interactions between the system's components or "agents." This activity is distributed over all parts (individuals) of the system, without a central controller supervising or directing the behavior. The term "self-organization" was first proposed by Ashby (1947). He noted that a dynamic system left on its own will spontaneously evolve toward what we now call an "attractor," a stable regime of activity toward which the system will tend to return even if disturbed. He further noted that in this regime the different components of the system are in a sense mutually adapted, so that they function in a coordinated, "organized" manner.

Heylighen (2012) tries to formulate a general conceptual foundation for the study of self-organization and apply this to the emergence of collective intelligence in groups. According to him, self-organization is a problem of coordination. At the very least, the actions of individuals in groups should not hinder, obstruct, or oppose each other, what Heylighen calls *the avoidance of friction*. As described earlier, coordination can be subdivided into four elementary processes or mechanisms: alignment, division of labor, workflow, and aggregation. *Alignment* means that the different actions (and therefore also their agents) "point in the same direction," or, more precisely, aim at the same target. However, if all agents merely act in the same way, their combined action will be at most quantitatively more powerful than their individual action. To reap the full benefits of cooperation, different actions need to complement each other. Only then can the activity achieve more than the sum of its parts, hence *division of labor*. *Workflow* is its complement. It coordinates activities that

take place one after the other, sequentially. To fully reap the benefits of synergetic action, we need a final mechanism of coordination, *aggregation*. Different agents contributing different actions at different times to a joint activity will be most effective when the fruits of their activity are assembled into a final product (Surowiecki, 2005).

COGNITIVE AND PSYCHOLOGICAL FACTORS IN KNOWLEDGE SYSTEMS

Cognitive factors in self-organizing processes point toward a critical factor for team coordination, the teams' mutual understanding of their task and situation—the *representation*, group mental models, or shared mental models (or to use Surowiecki's terminology, cognitive alignment). Mathieu et al. (2000) look into the coordination mechanisms of *shared mental models*. According to them, the shared mental model theory explains what the mechanisms of adaptability might be, that is, how teams can quickly and efficiently adjust their strategy "on the fly." The following sections provide more details regarding shared mental model theory and its relationship to effective teamwork.

Essentially, mental models are organized knowledge structures that allow individuals to interact with their environment. Specifically, mental models allow people to predict and explain the behavior of the world around them, to recognize and remember relationships among components of the environment, and to construct expectations for what is likely to occur next (see Rouse & Morris, 1986). Furthermore, mental models allow people to draw inferences, make predictions, understand phenomena, decide which actions to take, and experience events vicariously

(Johnson-Laird, 1983). Mathieu et al. define a mental model, in keeping with Rouse and Morris (1986), as a "mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states." Hence, mental models serve three crucial purposes: They help people to describe, explain, and predict events in their environment.

Cannon-Bowers et al. (1993) and others have argued that there is probably not a single mental model that must be shared among team members.

In fact, Klimoski and Mohammed (1994) contended that "there can be (and probably would be) multiple mental models co-existing among team members at a given point in time. These would include models of task/technology, of response routines, of team work, etc." Rentsch and Hall (1994) advanced similar notions and argued that team members' schema similarity (a concept quite like mental models) could be described in terms of both team work and task work. Table 1 describes several of these mental models.

Technology/equipment	Equipment functioning Operating procedures System limitations Likely failures	Likely to be the most stable model in terms of content. Probably requires less to be shared across team members.
Job/task	Task procedures Likely contingencies, scenarios Task strategies Environmental constraints Task components Relationships	In highly proceduralized tasks, members will have a shared task model. When tasks are more unpredictable, the value of shared task knowledge becomes more crucial.
Team interaction	Roles/responsibilities Information sources Interaction patterns Communication channels Role interdependencies Information flow	Shared knowledge about team interactions drives how team members behave by creating expectations. Adaptable teams are those who understand well and can predict the nature of team interactions.
Team	Teammates' knowledge Teammates' skills Teammates' attitudes Teammates' preferences Teammates' tendencies	Team-specific knowledge of teammates helps members to better tailor their behavior to what they expect from teammates.

Table 1: Types of shared mental models in teams (from Mathieu et al., 2000)

First, team members must understand the technology or equipment with which they are interacting. The dynamics and control of the technology and how it interacts with the input of other team members is particularly crucial for team functioning. Second, team members must

hold shared job or task models. Such models describe and organize knowledge about how the task is accomplished in terms of procedures, task strategies, likely contingencies or problems, and environmental conditions. Third, team members must hold shared conceptions of how the team

interacts. These models describe the roles and responsibilities of team members, interaction patterns, information flow and communication channels, role interdependencies, and information sources. The final model that team members must share is the team member model. This model contains information that is specific to the member's teammates, their knowledge, skills, attitudes, preferences, strengths, weaknesses, tendencies, and so forth (Mathieu et al., 2000).

Cannon-Bowers et al. suggested that teams that must adapt quickly to changing task demands might be drawing on shared or common mental models. The rationale behind their assertion was that to adapt effectively, team members must predict what their teammates are going to do and what they are going to need to do it. Hence, the function of shared mental models is to allow team members to draw on their own well-structured knowledge as a basis for selecting actions that are consistent and coordinated with those of their teammates. This is especially so under conditions in which communication is difficult because of excessive workload, time pressure, or some other environmental feature teams are not able to engage in necessary strategizing. In this case, shared mental models become crucial to team functioning because they allow members to predict the information and resource requirements of their teammates. Hence, members can act based on their understanding of the task demands and how these will affect their team's response. It is this ability to adapt quickly that enables teams in dynamic environments to be successful.

Heylighen (1999) calls the same phenomenon for coordinating a team "collective mental maps." He argues that obstacles created by individual cognitive limits and the difficulty of coordination can be overcome by using a collective mental map.

He defines it as a shared read/write access that represents problem states, actions, and preferences for actions. Using references to ant colonies and their pheromone trails, as well as termites and their heaps of mud, he puts forward the mechanism of "stigmergy." By following extremely simple rules, these low-intelligence individuals can create collective intelligence. Their communication is indirect, using pheromone tracks and dung heaps as their common ground for communication, stigmergy (from the Greek components "mark," i.e., stigma and "work," i.e., ergon). Similar objects for coordination are the ball in soccer games and money in the market economy. Collective mental maps can work as stigmergy if the collection and representation of data and information can be arranged in a way that is understood by the team. The total memory of the group can then become much larger than what is possible for an individual. A mixture of group memory, like a transactive memory system, and external storage in the form of writing, computers, and so forth, can be created. The representation, or collective mental map, will then function as a "decoder" of the group's learning ability since it will become the shared parts of the group memory. Hence, the collective mental map and its development will be critical to achieving collective intelligence. Theoretically, the ultimate mental map is as wide as it is possible for the group to hold together without them losing either oversight, ability to act or the ability to share, communicate, and understand each other.

Based on these arguments for the coordinating role of representation, another factor in group cognitive patterns influencing performance would then, of course, be *lack of consensus*. Ahearne et al. (2010) use a survey and archival data from a sample of 185 pharmaceutical sales teams to study team consensus and its impact on team performance. They argue that there is a problem when team members do not perceive/experience the inputs,

processes, and emergent states in the same way since lack of team consensus can create problems or magnify them. Conversely, strong consensus can prevent problems or diminish them. For example, it is more difficult for the group to formulate strategies and coordinate efforts when there is a lack of consensus about the environmental situation. This might suggest that the positive relationship between goal setting and performance should be stronger for teams that have a strong consensus about their environmental situation than for those who disagree on their environmental situation. Ahearne et al. even find that the cognitive factor of consensus affects the influence of behavior on performance. In their study, they find that high consensus regarding behaviors (LEBs or leadership empowerment behavior) and interpersonal climate quality enhances the team's potency, but only with high LEBS. It weakens team potency given low LEBS. The leaders' empowerment of the team is particularly advantageous when (1) the problem to be solved is not highly structured, (2) subordinates have more information than their managers for solving the problem, and (3) the solutions to the problem must be accepted by the subordinates to ensure implementation (Weitz, Sujan, and Sujan, 1986). In turn, team potency translates into sales team performance through both extra-role (team helping behavior) and in-role (team effort) behavior. The findings indicate that LEB and the quality of the interpersonal climate of the team can enhance the performance of sales teams by increasing the team's sense of potency, which leads to greater levels of effort and helping behavior. Also, the impact of LEB on team performance is stronger when team members agree on the extent to which they have been empowered by their leader and about the quality of the interpersonal climate. The study shows that when team members have a strong consensus about the extent to which they have been given autonomy and decision-making authority, LEB has a strong

positive effect on the team's belief that it can achieve its objectives. However, when team members disagree on the extent to which they have been empowered, the impact of LEBS is far less. A noteworthy aspect of this pattern of findings is that the teams with the least confidence in their ability to achieve their objectives are the ones that have not been empowered by their leader (i.e., low LEBS) and are certain of it (i.e., high LEBS consensus). Teams that have not been empowered by their leader but are uncertain about it have a greater sense of potency.

Another representation- and consensus-related concept is developed by Huber and Lewis (2010), *cross-understanding*. It is a group-level compositional construct having as its components each group member's understanding of each other member's mental model. They argue that this construct may explain some of the inconsistencies in the group literature and help explain how different levels and different distributions of cross-understanding affect group performance and learning. They develop this concept from one of these inconsistencies in the literature on group cognition, where the argument from the information/decision-making perspective is that high diversity in group cognition is positive for performance since it means access to more knowledge and perspectives. However, from the social categorization perspective, homogenous groups are said to be beneficial. So, their underlying question is rather: When or under what circumstances is cognitive diversion an advantage? It is here that they see the possibility of resolving some of these issues with the concept of cross-understanding. They argue that cross-understanding can mitigate the negative effects of strong subgroups. Cross-understanding enables group members to adapt to the views and behaviors of other group members. Hence, there are situations where we could expect negative

effects of diversity, but cross-understanding is why they do not appear. So, what do the authors mean with mental models and cross-understanding? Among the mental model features relevant to a group's task is *factual knowledge*, facts about the task or qualifications of group members. Also relevant are a member's *beliefs* about relationships among the task- and group-relevant variables, including cause-effect relationships. A third feature concerns the *scope* of the variables a member assumes to be within the task or group—for example, whether an issue is relevant to the group's task or whether it should be part of the group's problem representation. Finally, cross-understanding of other's mental models also includes other person's *sensitivity* to the relevance of particular issues or individual preferences, expectations, or demands (also known as utilities, values, or evaluative beliefs). These *preferences* may be politically motivated or otherwise self-serving or may be based on deep-rooted values, and besides influencing a person's choice-making propensity, they can influence the perceived validity of knowledge, reasonableness of cause-effect beliefs, or relevance of issues. The effect of cross-understanding on group effectiveness is via its influences on

- 1) the content and efficacy of members' communications,
- 2) by elaborating or modifying members' mental models, and
- 3) by affecting members' individual and collaborative behaviors.

Cross-understanding increases the *effectiveness of communication* by enabling members to choose concepts and words that are maximally understandable and minimally off-putting to other group members. An understanding of other members' mental models allows members to begin their conversations with other members, permitting them to tailor communication to refer to concepts, terms, and perspectives that members

have in common. When members are aware of what others know, believe, are sensitive to, and prefer, they are better able to inquire about the reasons underlying another's knowledge, beliefs, sensitivities, or preferences—for example, by asking for clarification or elaboration on matters related to that member's mental model. Such extended discussion helps members to develop enriched interpretations of matters relevant to the task or situation, to better understand the "big picture," and to come to a consensus about the key assumptions underlying members' knowledge, beliefs, sensitivities, or preferences. By better understanding what others know, believe, are sensitive to, and prefer, members are better able to anticipate other members' behaviors and thereby more effectively coordinate their actions with the actions of others. Insight into others' mental models also enables members to recognize when *other members' mental models* are different from theirs, alerts members to the possible need to adapt to this situation, and facilitates members' identification if appropriate adaptive behaviors (such as broadening their mental model or sharing information that other members apparently do not possess but might need to possess to participate more effectively in the group's processes). Thus, by helping members *anticipate and adapt to one another's actions*, cross-understanding facilitates coordination.

Group identity, or rather lack of it, is the next topic of cognitive factors in groups' self-organization, studied by Van der Vegt & Bunderson (2005). In multidisciplinary teams in the oil and gas industry, they examine the relationship between expertise diversity, team learning, and team performance under varying levels of collective team identification. They find that in teams with low collective identification, expertise diversity was negatively related to team learning and performance; where team identification was high,

those relationships were positive. These results further underscore the need to move beyond the simple diversity-affects-performance model to think in more complex ways about how and under what conditions a diversity of expertise in groups might promote or inhibit group effectiveness.

In the creation of group identity, individual team members can be instrumental in the success or failure. Adams and Anantatmula (2010) explore in an article social and behavioral influences of individuals on the project team and how those behaviors impact the team's social behaviors. A literature review is used to present a discussion of the development of *self-identity* and an explanation of how an individual's social and behavioral tendencies can influence the formation of social identity, group emotion, group mood, and emotional intelligence. According to their study, every team progresses through stages of social and behavioral development. See Figure 6 for how these relate, according to Adams and Anantatmula.

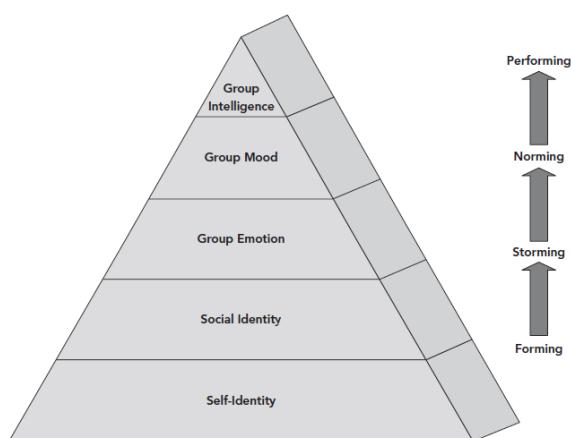


Figure 6: Hierarchy of social and behavioral development.

The stages are shaped by the self-identity characteristics that the team members bring to the

team. These characteristics have been developed within the family unit and through life experiences and make each team member unique. When team members interact with other individuals in a team setting, they project these characteristics in both verbal and nonverbal mannerisms and communications to shape the structure and behavioral personality of the team. The team then contributes to the individual's development of social identity. Studies show that an individual can consciously exhibit social behaviors, verbally or nonverbally, that influence acceptance, leadership, and team-status hierarchies. As a team continues to mature, transition to group emotion, group mood, and finally to emotional intelligence takes place. It can be deduced that since every team is composed of unique individuals, the team itself will also be unique to all other teams. Research, however, also points to the fact that, although each team is unique, the process of team development repeatedly conforms to the same pattern. Predictable stages of team development, with respect to the social and behavioral progression, can be delineated with characteristics.

PROCESS AND ORGANIZATIONAL FACTORS IN KNOWLEDGE SYSTEMS

From a process perspective, in relation to a phenomenon such as representation and self-organization, it has been argued that *group goal-setting* should be a key process. In a combined meta-analytic and narrative review, O'Leary-Kelly et al. (1994) assess the influence of group goals on group performance. Their review revealed a strong group goal effect. According to this study, groups who set goals perform a whole standard deviation better than groups who do not. Their conclusion is that this is probably due to the goal discussions helping the groups to clarify their representation and supportive coordination. Goal-setting theory suggests that goals are associated with enhanced

performance because they mobilize effort, direct attention, and encourage persistence and strategy development (Locke & Latham, 1990). According to individual goal-setting theory, goals are effective because they indicate the level of performance that is acceptable. Specific goals are critical to the individual goal effect because they establish one minimum acceptable performance level, but ambiguous goals either do not make clear the appropriate performance level or indicate to individuals that a range of performance levels is acceptable. In groups, the ambiguity surrounding the definition of acceptable performance may be increased because several goals operate simultaneously. Zander (1980) suggested that at least four types of goals exist in group contexts: (1) each member's goal for the group, (2) each member's goal for himself or herself, (3) the group's goal for each member, and (4) the group's goal for itself. In view of the existence of these numerous and potentially inconsistent goals, it is likely that goal specificity will also be critically important to the group goal effect. Individual-level goal-setting theory also suggests that the degree of difficulty associated with a goal is a critical issue. Difficult goals, if accepted, lead to greater individual effort and persistence (Locke & Latham, 1990; Locke, Shaw, Saari, & Latham, 1981; Tubbs, 1986). Although it is likely that difficult group goals are associated with increased group member effort and persistence, it is important to recognize that the group context provides other stimuli to effort and persistence. For example, previous research suggests that the cohesion of a group may influence group performance, with members of cohesive groups more likely to participate in coordinated patterns of behavior (Levine & Moreland, 1990). Members of a cohesive group working toward an easy goal might, therefore, exert effort beyond their expected individual contributions in order to maintain goodwill within the group. If several group members do so, even easy goals may be associated with high group

performance. On the other hand, research on social loafing (e.g., Price, 1987) has demonstrated that group members who feel their contributions are unidentifiable may exert little effort on behalf of a group. If several members engage in this behavior, even difficult goals may be associated with low group performance. The group context, therefore, adds complications to the goal difficulty issue that are not evident at the individual level, making its relationship to group performance particularly worthy of consideration.

Another process perspective on representation and self-organization is *interdependency* between team members, which is what Stewart & Berrick's (2000) study of 45 production teams looks at. Several researchers have hypothesized that variation in team performance can be explained by differences in team structure (Cohen & Bailey, 1997; Gladstein, 1984; Hackman, 1987; Wageman, 1995). This study was thus designed to determine how team structure relates to team performance. Organizational theorists have defined structure as the configuration of relationships with respect to the allocation of tasks, responsibilities, and authority (Greenberg & Baron, 1997). In their review of factors that correlate with team effectiveness, Campion, Medsker, and Higgs (1993) identified two important elements of team structure: interdependence and team autonomy/self-leadership. Prior research on small groups and teams and sociotechnical systems has suggested that *task differences* moderate the relationships between group inputs, processes, and outcomes. For teams engaged primarily in *conceptual tasks*, Stewart and Berrick find that their expectation of a U-shaped interdependence-performance relationship was confirmed. However, they found that intra-team processes mediated the relationship between interdependence and performance in these teams. Very high or low levels of interdependence were

related to both open communication and less conflict among team members. These socioemotional processes were, in turn, associated with higher team performance. The extremes of interdependence thus seem to be alternative paths to a desirable end when teams perform work that has a conceptual focus. Consistent with much of the literature related to team autonomy, greater team self-leadership was also found to correspond with higher performance for teams primarily engaged in conceptual tasks. Team designs that incorporated moderate levels of interdependence and greater external leadership were found to be more effective when teams were engaged in *behavioral tasks*, suggesting that relationships between structure and performance in behavioral tasks are the inverse of those for teams primarily engaged in conceptual tasks.

Another perspective of process factors influencing groups acting as a system is their strategies for dealing with *external relations*. Using this external perspective as a research lens, Ancona (1990) examined team-context interaction in five consulting teams. The data revealed three strategies toward the teams' environment: (1) informing, (2) parading, and (3) probing. Informing teams remain relatively isolated from their environment; parading teams have high levels of passive observation of the environment, and probing teams actively engage outsiders. Probing teams revise their knowledge of the environment through external contact, initiate programs with outsiders, and promote their team's achievements within their organization. In this study, they were rated as the highest performers among the teams, although member satisfaction and cohesiveness suffered in the short run. Results suggested that external activities are better predictors of team performance than internal group processes for teams facing external dependencies. Traditional models of group process tend to treat groups as

closed systems that act as settings shaping individual attitudes, attributions, and decisions (Stephan, 1984). Whether group research has stemmed from the humanistic or the decision-making school of management scholarship or from social psychology, the focus has been on the interaction among group members (Gladstein, 1984). Existing models predict that a group's performance will be high to the extent that it manages its internal processes. However, since organizational groups have high external demands, it is important to extend the theoretical lens from the team boundary outward. This shifts the focus to the group in its context, and the group is assumed to have an existence and purpose apart from serving as a setting and apart from the individuals who compose it. From this perspective, teams that can manage their external dependence and obtain critical resources should perform better than those that are able only to manage their internal dynamics. The study suggests that teams develop three different strategies toward their environment. The strategy of informing called for concentration on internal team process until the team was ready to inform outsiders of its intentions; parading consisted of simultaneous emphasis on internal team building and achieving visibility that would allow outsiders to see that members knew and cared about them; and probing stressed external processes, requiring team members to have a lot of interaction with outsiders to diagnose their needs and experiment with solutions.

Finally, a more philosophical perspective on the relationship between organizational and collective intelligence is taken by Raye (2014), who discuss how *hierarchies* cause problems for the natural flow of information. Her argument is that top-down hierarchies typically are characterized by command-and-control systems of authority that often create harmful stress and internal

competition for advancement. The perception of “limited room at the top” cause people to withhold or hoard information by focusing competition energy internally rather than externally. This would explain the creation of silos of information and negative stress in organizations. Voluntary turnover drains talent as creative individuals tire of the politics and seek harmonious work environments. “Change management” becomes an issue, as members’ natural compulsion to provide feedback and insights is limited. The triangular shapes of top-down hierarchies are non-random and limited, according to Benoit Mandelbrot, which may explain why many top-down organizations typically grow through acquisitions rather than by expanding from within. The more natural organization, according to Raye, would follow the fractal geometry of living systems in nature, which is both random and scalable, ensuring pattern integrity during evolutionary adaptations. Fractal organization theory recognizes an emergent human operating system that mimics nature in its capacity for creativity, adaptation, vitality, and innovation. The qualities of a fractal organization include “shared purpose” and “values” that create *pattern integrity*, universal participation in ideas and solutions for continuous improvement, decision-making at functional levels, leadership devoted to universal leadership, and competition energy directed outwards instead of inwards. Relationship development enables the effective flow of information between individuals and among teams. At all levels of a fractal organization, members share information iteratively and make decisions collectively in response to constantly changing conditions.

STIMULATING GROUPS TO ENACT INTELLIGENT SYSTEMS

As a general introduction to this section, I will use a meta-analysis by Klein et al. (2009) conducted to answer the question: Does team-building work?

Their research reports the results of a comprehensive investigation into the effectiveness of team building. The study considers the impact of four specific team-building components (goal setting, interpersonal relations, problem solving, and role clarification) on cognitive, affective, process, and performance outcomes. Results (based on 60 correlations) suggest that team building has a positive moderate effect across all team outcomes. In terms of specific outcomes, team building was most strongly related to affective and process outcomes. Specifically, the finding that the role-clarification and goal-setting components improved performance over the other teambuilding components could benefit practitioners and organizational managers by providing increased clarity into ways in which leaders may best direct their teams (i.e., being clear about subordinates’ roles and setting goals). The study also suggests that team building has a greater impact on some outcomes over others, and some team sizes over others. In a case where a manager suspects that his or her team may benefit from team building it would serve the manager to evaluate and identify the team’s characteristics, as well as the specific problems encountered prior to intervening with team building. The results also reinforce the view that not all teams will benefit from the same team-building intervention.

If we want to work on an organizational level, with improving groups or individuals enacting groups, Mohr et al. 2004 suggest the micro-system concept, developed originally in studies of large health-care organizations. Micro-systems usually coexist with multiple other micro-systems within the organization. These cross-micro-system relationships will be essential to improving handoffs but also to provide opportunities for learning about systemic problems within the organization. However, for voluntary interactions across organizations, several conditions must be met, according to Mohr et al. There must be an internal need for resources, a commitment to an

external problem, and the opportunity to change. Also, there must be a consensus on the external problem(s) facing the organizations as well as a consensus on the specific goals and services for developing a joint effort.

As a foundation for connecting micro-systems and hence create organizational intelligence or performance, it is suggested that the following factors are crucial:

- *context*—refers to the environment in which the partnership exists, the internal and external stakeholders, their historical relationships and influence, the presence or absence of human and financial resources, the political environment, public sentiments, and the current challenges facing the community;
- *strategic intent*—a similar concept to a consensus on the external problem(s) facing the organizations, refers to the reasons the inter-organizational relationship is formed;
- *resource base*—a diversified resource base helps assure that the collaborative can pursue their strategic intent without getting sidetracked by pursuing the goals of a single funding agency;
- *membership heterogeneity*—refers to the balance of the participating members regarding the number and types of participants;
- *coordination skills*—informal as well as formal communication mechanisms assure that the collaborators meet their own goals and are held accountable to demonstrate their progress internally and externally;
- *response to accountability*.

Witte & Engelhard (2004) also argue that as complexity increases, the groups or micro-systems become the key to effective organizations.

However, they examine moments of cooperation and how groups tend to perform in relation to their potential. Their conclusion is that groups normally underperform in relation to potential and that group-processes, therefore, should be facilitated to increase efficient coordination. For this, they compile a series of postulates shown below that they argue should guide the development of coordination models and methods for groups or micro-systems.

- 1) The higher the quality of individual input regarding subject matter at the beginning of the group interaction, the higher the quality of the group performance (Lorge & Solomon, 1955; Grofman, 1978; Sorkin, Hays, & West, 2001).
- 2) The more individual inputs are independent of one another at the beginning of the group interaction, the higher the quality of the group performance (Sorkin, Hays, & West, 2001).
- 3) The more the group performance includes individual input, the higher the quality of the group performance (Hinsz, Tindale, & Vollrath, 1997).
- 4) The more comprehensible the individual input is for each group member, the higher the quality of the group performance (Libby, Trotman, & Zimmer, 1987).
- 5) The higher quality of individual input that influences the final group decision, the higher the quality of the group performance (Littlepage, Schmidt, Whisler, & Frost, 1995).

Heylighen (2012) argues that working with and stimulating collective intelligence in groups should address the most important issues to avoid in a collective process, namely the tendency for “groupthink.” This is the phenomenon where people in a group all start to think the same, because a slight initial preference for one approach rather than another becomes amplified via positive feedback. This happens partly because hearing a

certain approach will “prime” the mind to consider things from the same perspective, partly because people tend to be conformist, and do not like to contradict or appear to be in conflict with others. A more extreme version of this process leads to the phenomenon of group polarization (also known as “risky shift”). This refers to the common observation that groups tend to be more extreme in their judgments after a discussion than the members were individually before the discussion. Groupthink and group polarization are examples of self-organization gone wrong, where non-linear interaction has led to premature alignment on a suboptimal solution, and where the positive contributions of diversity and division of labor have been neglected. Heylighen argues that the simplest way to avoid groupthink is to disallow direct communication between the group members so that the one cannot influence the other one until everyone has been able to make a full contribution. However, a collective solution still requires an aggregation mechanism that integrates these different contributions. The result can, therefore, be improved if the different members express their opinions independently and anonymously (e.g., on a computer-supported discussion system) before they start responding to the opinions of others, and if the discussion is guided by a neutral moderator, who ensures that everybody duly answers all the important questions, and responds to criticisms of their previous answers. The anonymity makes sure that everybody’s ideas are given equal attention (instead of the discussion being dominated by the more authoritative people). This is also the basis of the so-called Delphi method that aggregates the ideas of a panel of experts, via several rounds of anonymous, mediated discussion.

Regarding representations, Mathieu et al. (2000) find in a study of 56 dyads that greater mental-model convergence relates significantly to better team process and thereby performance. This suggests that efforts to increase team members

shared models might lead to greater team effectiveness. One strategy for doing so might be to investigate common underlying cognitive abilities or experiences that give rise to certain knowledge structures. In other words, if individual differences can be tied consistently with the development and use of particular mental models, then teams might be composed to enhance team mental models. If so, traditional human resources efforts such as selection, staffing, and placement could be used to achieve such matches. Alternatively, or perhaps in addition, there are a variety of intervention strategies that could help to develop shared mental models, for example, training application, job rotations, feedback programs, or exposure to certain events. In any case, there appear to be many different avenues that can be pursued to help team members develop shared mental models. A second finding from this research by Mathieu et al. is that different types of mental models can be identified and assessed and that they have unique influences on team processes. The findings suggest that researchers and practitioners should conduct thorough team task analyses to identify the most critical knowledge requirements for a given situation and which of those knowledges must be shared. One final direction for future research warrants mentioning. High mental-model convergence, as operationalized here, does not imply that the models formed by the team members are appropriate. In other words, convergence does not equal quality—and teammates may share a common vision of their situation yet be wrong about the circumstances that they are confronting.

Regarding *team consensus*, the Ahearne et al. (2010) study suggests three things that can be addressed from a management perspective. *First*, their study demonstrates that interpersonal climate *consensus* plays a critical role in determining whether the benefits of a leader’s

empowerment behavior are realized. Waterson et al. (1999) found that 54% of the companies responding reported little improvement or only moderate gains from their empowerment programs. One reason for this may be that if team members are not able to motivate each other and manage their conflicts, empowering them is not likely to pay dividends—and may well be counterproductive. The research suggests that management needs to focus greater effort on fostering positive interpersonal climate in teams. Managers can do this by, for example, encouraging team members to (1) identify the parameters of conflict, (2) develop norms for cooperative rather than competitive approaches to conflict resolution, (3) recognize the importance of providing feedback to teammates on team success, and (4) use team-building interventions to develop effective means of regulating team member emotions. *Second*, they found that empowerment increases team potency, effort, helping, and sales performance, which suggests that sales organizations should consider how they can encourage managers to engage in empowerment behaviors. They can do this by increasing awareness of the forms of empowerment behavior, training managers on how to exhibit the behaviors, and reinforcing them when they do so. Also, given the moderating effects of a team's consensus about its empowerment, it is important for managers to exhibit these behaviors consistently in the presence of all team members and emphasize the authority and autonomy delegated to the team. To the extent that these efforts are successful, the findings suggest that team performance will improve. *Thirdly*, the interaction between leadership empowerment behavior and consensus has two implications. First, it implies that if a manager wants to empower a team to increase its sense of potency (and, ultimately, its performance), he or she must try to increase the team's consensus about its empowerment. Second, something as simple as instituting a more frequent and

consistent meeting schedule with sales teams could help enhance team consensus.

When it comes to the concept of *cross-understanding*, Huber and Lewis (2010) argue that perhaps the largest potential contribution of this concept is to foster better analysis and understanding of the complexity of groups. The concept helps to describe how different levels and different distributions of cross-understanding affect group performance and learning. Low cross-understanding is associated with low group learning and performance, and high cross-understanding is generally associated with high group learning and performance. These effects are predicted to hold irrespective of whether members' mental models are similar or diverse. That is, high cross-understanding should mitigate the negative impact of the discussion bias favoring commonly held information, as well as allow members of diverse groups to make the most of their diversity by encouraging members to surface, discuss, and integrate their different understandings and perspectives. High cross-understanding can, however, have negative effects on group processes and performance when members are motivated to use their understanding of others' mental models to either (1) create or shape arguments that will lead to group product features favorable to them or their unit, rather than features that enhance the quality of the group's product, or (2) surface and discuss primarily information that will increase their social standing rather than contribute to the group's task. Cross-understanding between members of different subgroups should also help mitigate against the divisiveness that might otherwise occur when subgroups are present. The implication of cross-understanding suggests that having teams consisting of highly diversified mental models no longer need conflict with the ability to become an efficient team. Teams with members that have

diverse knowledge and high ability for cross-understanding should be able to leverage diversity more efficiently. Stimulating cross-understanding should be possible, both through facilitation, methodology, and the use of information systems, according to Huber and Lewis.

The studies of *interdependencies* by Stewart & Berrick (2000) demonstrate that type of task is an important moderator. The correlations suggest that teams with behavioral tasks tend to have greater interdependence. Perhaps this is because interdependence is easier to create when a task is routine and behavioral. However, the analyses suggest that teams primarily performing conceptual tasks are the very ones that can benefit most from relatively high levels of interdependence. The study also suggests that teams performing more conceptual tasks have more self-leadership, and the analyses suggest this greater self-leadership is functional. Practically, the results of the study have implications for determining optimal methods of work-team design. Organizations using teams to complete conceptual tasks can benefit from either very high or very low levels of interdependence, as well as greater self-leadership. In contrast, when work tasks are primarily behavioral in nature, moderate amounts of interdependence and greater external leadership seem best, according to Stewart and Berrick.

Van der Vegt and Bunderson's (2005) study of *group identity* offers several implications for practitioners trying to manage expertise diversity in multidisciplinary work teams. First, their findings suggest that it is important for managers to create the proper mix of expertise in assembling teams. Too little or too much expertise diversity within a team may dampen team learning behavior and decrease team performance. Moderate levels

of expertise diversity within a team make it more likely that members will utilize their different perspectives and learn from one another—if they also identify with their teams. Consequently, it is important that managers take measures to foster a high level of collective team identification within their moderately diverse teams. According to the researchers, organizations can encourage collective team identification by creating the right mix of task and goal interdependence among team members, by showing support and recognition, by allowing teams to develop a shared history together (rather than changing membership frequently), and by increasing contact among team member, according to Van der Vegt and Bunderson.

On the topic of *identity*, Adams and Anantatmula (2010) use the project as the basis for discussing implications of the relationship between self-identity and team development. They argue that self-identity is the first developmental stage and the most basic form of social and behavioral development within the context of a team setting. The self-identity stage is prevalent during the forming phase of the team and may require a more directive management style. Communicating clear expectations and reinforcing the team mission while encouraging the team to evolve as a unique group should, therefore, be a priority. On a practical basis, the researchers suggest that the project manager could, for example, meet with each team member to understand the individual's background and motivation, to assess the individual's strengths, and to determine their potential contribution to the team. They continue to advise on *project manager behavior during the different development phases of the group*. The project manager should have a heightened awareness during initial meetings to derail any negative tendencies toward social, behavioral, or minority-biased issues.

The project manager should insist on and reinforce positive social behaviors, such as politeness, as the team starts to build relationships and to minimize conflicts arising from personal differences. As individuals progress in the team process to the storming phase, social identity with the team will begin to emerge. To engage team members, the project manager should be selective in matching team members to specific activities that will spur interest and professional growth, as well as provide a sense of personal satisfaction. For example, individuals who are identified as having a high need for affiliation can be used to promote team-building activities, while individuals with a high need for achievement can be requested to contribute to the development of task-oriented activities. When the team moves to the group emotion stage, the norming phase begins. Now, the project manager should be aware of his or her personal emotions, since the demonstration of positive emotions is important to being perceived as the leader. When negative emotions surface, the project manager should allow for team reaction but then take measures to bring the team back to a positive state. As the team enters the group mood stage, team members and the project manager should be attuned to each other's behaviors. Occurring in the late norming phase, the project manager's management style should become increasingly more supportive, rather than directive. Once the team matures to the emotional intelligence stage, the project manager will have minimal influence over the team process. The team will be in the performing phase, operating as a unit, and will be self-managed. At this stage, the team turns attention back to the individual. Since the team sets norms for behaviors and emotions, any negative behaviors will be dealt with quickly by the team and in a caring manner. The project manager should continue to monitor the team's social behaviors but should not be too quick to intervene, so as to prevent disruption of the natural

team process. All this advice to project managers is from Adams and Anantatmula.

As a complement to such practical advice, Raye (2014) offers a more philosophical perspective on the challenges of current management and leadership. According to Raye, top-down hierarchies emerged when it was common to view uneducated workers as less worthy, resulting in a lasting movement for worker's rights that pits management against workers, harms productivity, and often influences the relocation of many manufacturing businesses to less developed countries. The author continues to argue that an increase in turnover over the last few decades and the high costs of training replacement workers might be incentives enough to change an organization's structure from top-down to fractal, although a shift in consciousness will also be necessary. When leaders recognize the critical importance of feedback from workers who interact with an organization's environment in their daily efforts, they may be more inclined to institute changes in their organization that reflect the value of this information or to create structures that are more egalitarian and inclusive of participation. The practice of leaders as "conduits of information flows" is vital to the success of this approach, as the quality (and quantity) of information exchanges within and outside of the organization is key to successful adaptation. Leaders who monitor and work to improve the dynamics of information flows within their organizations will ensure the best outcomes in rapidly changing environments. The health of a workforce is a direct reflection of the quality of information flowing within an organization. Raye claims that the negative stress of discordant relationships and poor communication practices results in physically damaged bodies that require expensive healthcare and reduce productivity. Finally, she concludes that groups of people who share a purpose and

core values create a healthy environment in which individuals thrive and collaboration is valued and rewarded. The fractal nature of such organizations reflects our shared consciousness where information influences both energy and matter.

The Ancona (1990) study has both managerial and theoretical implications. For managers, team building must be tailored to a group's task. The balance between internal and external focus depends on how much a team needs outside resources, support, or information. Despite the advice of current texts, teams that automatically and exclusively focus inward may be low performers in the long run. Teams with external evaluators, task allocators, and clients may find that developing externally focused roles is as important as developing internal process skills. This study, using an external lens, called for specifying the aspects of composition, structure, and context that most influence process and performance and for including a new set of variables in the model for group performance. The results reported here call for highlighting the clarity of managerial vision, the nature of autonomy, and the degree of external demands and change as key aspects of context. Results also suggest including external strategies such as informing, parading, and probing and the interaction of internal and external activities as key process variables.

General maxims for group facilitation techniques could be read as follows, according to Witte & Engelhard, 2004:

- 1) Maximize the informational influence on the group performance process,
- 2) minimize the normative influence on the group performance process, and
- 3) optimize the influence of individual input on the final group decision.

Teams often comprise experts of various subject areas. Each of those experts has specialized knowledge which other group members do not have (unshared knowledge). Also, the group's resource includes knowledge which is at the disposal of all group members (shared knowledge). Conformity processes, as part of normative pressure in groups, result in primarily shared knowledge entering a consensual group decision, and specialized knowledge remaining unnoticed (shared view effect). Thus, unique resources of single group members must be explicitly extracted and communicated to the group (Hoffman, Shadbolt, Burton, & Klein, 1995). The importance of each contribution of knowledge regarding the group decision should then be evaluated by the group. Therefore, all comments, arguments, and individual positions must be presented to the group in a clear and comprehensible way, as they cannot be taken for granted per se, especially so as specialists in a certain field often tend to underestimate the complicated nature of their expertise. To sum up: the quality of group performance regarding non-eureka tasks depends considerably on the addition of shared and unshared knowledge in groups and how it is evaluated.

One critical tool for working on the development of team performance would, of course, be to have valid measures on different team factors. Anderson & West (1998) develop one such measure, TMI, or team climate inventory. Their paper reports the development and psychometric validation of a multi-dimensional measure of facet-specific climate for innovation within groups at work. Many definitions of climate have been put forward, but two approaches are argued to have received substantial support, the cognitive schema approach and the shared perceptions approach. The former conceptualizes climate as individuals' constructive representations or cognitive schema

of their work environment. Superordinate to this focus at the individual level, other authors have emphasized the importance of shared perceptions as underpinning the notion of climate. Organizational climate is then the shared perception of the way things are around the group, such as organizational policies, practices, and procedures. Another controversial issue in climate research has been the meaning of the construct itself, and its operationalization in applied research. A suggested way forward has been instead to talk about “facet-specific climates,” giving it a referent, for example, climate for change, climate for quality, and climate for innovation. Anderson and West then build on previous research to develop a four-factor theory for climate for work group innovation: *vision*, *participative safety*, *task orientation*, and *support for innovation*. Vision is defined as an idea of a valued outcome which represents a higher-order goal and a motivating force at work. Participative-ness and safety are characterized as a single psychological construct in which the contingencies are such that involvement in decision-making is motivated and reinforced while occurring in an environment which is perceived as interpersonally non-threatening. Task orientation is a shared concern with excellence of quality of task performance in relation to shared vision or outcomes, characterized by evaluations, modifications, control systems, and critical appraisals. Finally, the support for innovation is the expectation, approval, and practical support of attempts to introduce new and improved ways of doing things in the work environment. The study of Anderson & West then shows that by focusing on a specific aspect of climate and its relationship to specific aspects of group-level outcomes, greater predictive accuracy is achieved.

Another type of support for stimulating groups as systems is, of course, the use of communication and collaboration software. He et al. (2007) discuss the growth and development of team cognition

and how that supports team coordination. In software development, team-based work structures are commonly used to accomplish complex projects. Software project teams must be able to utilize the expertise and knowledge of participants without overwhelming individual members. To efficiently leverage individuals' knowledge and expertise, software project teams develop team cognition structures that facilitate their knowledge activities. The He et al. study shows how communication activity and team diversity impact the formation of these structures. A five-week longitudinal study was conducted of 51 database development teams, in order to analyze how communication activities and team characteristics affect the team's shared knowledge of its expertise and task—that is, awareness of expertise location and shared task understanding. The results suggest that initial member familiarity strongly influences awareness of expertise location and shared task understanding within a team. “Familiar teams”—those with high levels of familiarity—had higher levels of team cognition than unfamiliar teams. However, the favorable effect of familiarity on team cognition faded over time. Later in the projects, familiar teams and unfamiliar teams achieved about the same levels of team cognition. The analysis indicates that while familiarity is important in the early stages, teams can achieve a similar level of team cognition as time passes. The results also reveal that different communication methods employed in the teams had different effects on team cognition. The number of e-mails had no effect on team cognition or team performance. Meetings and phone calls were associated with both elements of team cognition (awareness of expertise location and shared task understanding). Similar results have been reported in other recent cognition studies, concluding that face-to-face communication is the most helpful communication mode. According to information richness theory, e-mail is less effective than phone calls and meetings in that it is the most

limited communication method of the three in terms of the amount of information being conveyed. Also, modes of team communication that rely on face-to-face contact, such as meetings, are more likely to create opportunities for team members to learn from peripheral participation. Overall, this suggests that although e-mail may be a valuable communication tool, software project teams must recognize that relying too heavily on e-mail may ultimately undermine the team's ability to form team cognition structures, and thus, they may find it more difficult to perform effectively. Finally, team cognition evolves over time. The data analysis concluded significant and positive coefficients for the time variable. The results provide evidence that team cognition evolves over time as team members work together.

To summarize, it's apparent that teams become collective through the team members' coordination of their thoughts and actions. The enactment of something collective will therefore ultimately depend on how synchronized the mental models of the participants are. Models telling them what is going on, what the team is supposed to do, how, when and maybe most important, why. Beyond that, the function and quality of the collective will depend on the effort behind the individual micro-actions performing the actions of the collective. Understanding and developing the mental models, and different aspects of them, are therefore critical in the development and function of teams, which becomes clear in this selection of research and by their results.

INDIVIDUALS COORDINATING INTELLIGENT SYSTEMS

HEEDFUL INTERRELATING

Our final perspective on collective intelligence is the group as the sum of individual actions. Weick and Roberts (1993) used the concept of heedful interrelating to explain the necessary effort in coordination by individuals to make complex knowledge systems work in high-risk organizations. They also argue that it is variations in heed that explain the quality, or intelligence, of the system. This section will therefore start with some different perspectives on this quality label of individual coordination in team work; heedful interrelating.

In a study from 2004, Cooren demonstrates how the concept of *heedful interrelating* can be applied to explain coordination in ordinary organizations (as opposed to reliability organizations) and ordinary work group activities, such as group meetings. Based on her in-depth analysis of excerpts from a board meeting in a drug rehabilitation center, she shows how a group of managers displays a form of intelligence that cannot be reduced to the simple sum of their respective contributions. Although this phenomenon has been illustrated in the context of high-reliability organizations, this analysis extends previous findings by showing that this form of collective intelligence can be found more generally, for example, in patterns of conversational behavior. In the study, managers are constructing, amending, and adding a series of textual blocks that ultimately represent the heedfulness of the group. Although it can be achieved only in interactions, collective minding is a phenomenon that transcends the "here and now" by interrelating

this latter with the “there and then,” a phenomenon Cooren calls *translocalization*, and that can be called a form of organizational intelligence. Through the degree of heed, the process of translocalization of knowledge in the organization is influenced. That is, how the situations and problematics of the organization are brought into the meeting by connecting phenomena from other time-spaces (spatiotemporal dimensions) to the talking, there and then. In this, the individual actions turn into a system with different capabilities due to their heedful interrelating. From this system, a representation grows that becomes both the basis for and the result of learning processes.

Kilduff et al. (2000) also relate the process of integrating knowledge in efficiency organizations to heedful interrelating. In an experiment using data from 35 simulated firms run by a total of 159 managers attending executive education programs, their research tested several hypotheses concerned with the relationship between demographic and cognitive team diversity and firm performance. The results showed that members of high-performing teams tended to preserve multiple interpretations early in the team's life cycle, but that they moved toward greater clarity near the end of the life cycle. These high-performing teams, therefore, exhibited both *early interpretative ambiguity* and *late heedful interrelating*. An interesting note is that there was no evidence of any effect of demographic diversity on measures of cognitive diversity. The demographic diversity studied was functional specialization (e.g., marketing, research, and development, etc.), national origin (e.g., French, German, etc.), and age. Regarding cognitive diversity, the researchers draw on a sense-making perspective (Weick, 1979, 1995) to argue that cognitive diversity can be either a blessing or a curse, depending on the specific type of cognition

involved. From a sense-making perspective, the preservation of multiple interpretations in teams is critical for registering complex environments. Weick reasons that for the detailed registering necessary for successfully coping with a complex, equivocal environment, the variety within the organization must match the variety outside it (Weick, 1979; cf., Ashby, 1952). Interpretive ambiguity within the top management team preserves the requisite variety needed to sense and regulate the variety facing the organization. Interpretative ambiguity is defined as follows: Lack of clarity within the team concerning the degree to which team members share common attributions concerning, for example, organizational success and failure. It is important to note here that the interpretative ambiguity valued by Weick should be distinguished from disorganization on the one hand (i.e., teams in which everyone explicitly disagrees with everyone else) and unanimity or groupthink on the other (i.e., teams in which everyone agrees with everyone else). Interpretative ambiguity resembles most closely that state of equivocality in which both agreement and disagreement concerning the environment are simultaneously possible, allowing the same reality to be perceived by team members in different but complementary ways. As Weick (1995) points out, in organizations characterized by strategic ambiguity "people are not pressed to articulate their individual understanding" of causal connections. Thus, people act effectively together without the team as a whole ever clarifying how much interpretative ambiguity exists. Previous research from a sense-making perspective has shown that teams can act effectively despite an absence of shared meanings (Donnellon et al., 1986) or shared goals (Bourgeois, 1980). From this perspective, efforts to clarify team disagreements may damage performance. The results of the study showed that teams that ended the simulation with high performance tended to reduce the degree of ambiguity over the course of the simulation, even

though they tended to start out with high interpretative ambiguity. Exactly the opposite pattern was observed for low-performing teams. The authors conclude (Kilduff et al., 2000) that one of the major tasks of management is to maintain within teams a rich possibility for sense-making while at the same time promoting coordinated work. The cycle of ambiguity and clarity may represent one dynamic solution to the twin problems of impoverished sense-making on the one hand and uncoordinated activity on the other. How can teams foster both equivocality and mutual understanding? The answer from the present research is to take advantage of the natural cycle of work: In the beginning let ambiguity flourish; in the end clarity. Let heedful interrelating keep the team together.

Finally, on the topic of heedful interrelating, Faraj and Sproull, in a study from 2000, also demonstrate how knowledge must be coordinated through “expertise coordination,” that is, the team members actively “bringing expertise to bear,” and they argue that this must be done with “heed.” Like all teams, knowledge teams must acquire and manage critical resources to accomplish their work. The most critical resource for knowledge teams is expertise, or specialized skills and knowledge, but the mere presence of expertise on a team is insufficient to produce high-quality work. Expertise must be managed and coordinated to leverage its potential. That is, teams must be able to manage their skill and knowledge interdependencies effectively through expertise coordination, which entails knowing where expertise is located, knowing where expertise is needed, and bringing needed expertise to bear. Their study investigates the importance of expertise coordination through a cross-sectional investigation of 69 software development teams. The analysis reveals that expertise coordination shows a strong relationship to team performance that remains significant over and above team input characteristics, presence of expertise, and

administrative coordination. They propose that for expertise coordination to be effective, processes that are distributed, heedful, and emergent must occur. These processes are distributed because expertise is dispersed among team members. They are heedful because overlapping task knowledge allows flexible and supportive joint action, and they are emergent because answers or solutions are not pre-specified but are generated through interactions. It is not sufficient to recognize where expertise is located or where it is needed; a team needs to develop ways by which expertise is promptly brought to bear on the problem. Formal processes of arranging for expertise access such as contracts for database access are not likely to be sufficient for complex and interdependent tasks because they cannot predefine what kind of expertise is needed. Thus, teams need to rely on an emergent process of informal interactions and joint problem-solving to bring expertise to bear.

PSYCHOLOGICAL FACTORS IN INDIVIDUAL COORDINATION

Relating to many of the studies mentioned above, (Salovey & Mayer, 1990; Gant & Agazarian, 2004; Goyal & Akhilesh, 2007), an important factor in individual coordination should be *individual emotional intelligence*. The authors Moore and Mamiseishvili (2012) investigated the relationship between emotional intelligence and group cohesion by studying 44 undergraduate teams who were completing semester-long projects in their business classes. The results showed that there was a significant positive correlation between group overall emotional intelligence and total group cohesiveness. Of the quadrants of emotional intelligence, awareness of own emotions, and management of others' emotions showed the strongest positive correlation with group cohesion.

In her dissertation, Stubbs (2005) examines the relationship between *team leader emotional*

intelligence, team-level emotional intelligence, and team performance. She argues that a team leader's emotional intelligence (EI) will influence the development of group-level emotional intelligence, which was measured by a teams' emotionally competent group norms (ECGN). Secondly, she hypothesized that the presence of ECGNs would positively influence group effectiveness. Data were collected from 422 respondents representing 81 teams in a military organization. Results showed that team leader emotional intelligence is significantly related to the presence of emotionally competent group norms on the teams they lead, and that emotionally competent group norms are related to team performance.

Going into the details of the relationship between emotional intelligence and collective intelligence, the Othman et al. (2009) paper looks at the moderating effect of *work motivation* on the relationship between emotional intelligence (EI) factors (self-emotional appraisal, others' emotion appraisal, regulation of emotion, and use of emotion) and team role effectiveness. The basic question is: Under what conditions of work motivation do EI factors influence team role effectiveness and how? Analyses of 167 responses from service providers and their superiors revealed that the interactions between work motivation and emotional intelligence factors (SEA and OEA) have a significant effect on service providers' team role effectiveness. SEA is defined as the individuals' ability both to understand their deep emotions and express these emotions naturally. A sample item is "I have a good sense of why I have certain feelings most of the time." OEA is defined as one's ability to perceive and understand the emotions of those people around them. A sample item is "I always know my friends' emotions from their behavior." The effect of SEA on team role effectiveness is positive for those with low work motivation while for the high work motivation group the effect is initially positive but turns negative at high SEA

levels. The effect of OEA on team role effectiveness is higher for low work motivation groups, and for both low and high motivation groups the moderation effect is positive at the low to moderate levels of OEA but becomes negative at high levels of OEA.

The findings indicate that the effect of SEA and OEA on team role effectiveness is somewhat moderated by work motivation, but the effects are complex and counterintuitive. The findings imply that optimal team role effectiveness is achieved by employees with moderate SEA or ability to understand and express emotions and high motivation. The relationships may be explained by the highly motivated and high SEA employees being unable to control their emotions and therefore risking damage to team unity and creating tensions. Optimal team effectiveness is achieved when moderate SEA combines with high motivation. The findings also reveal that employees with moderate and high OEA work more effectively as a team (as perceived by their supervisors) when they have low positive drive (feelings of self-satisfaction from doing a good job). The reason behind the findings may be that with high SEA and OEA, the employees may become egocentric individuals, too proud of personal achievement to work effectively with others. Moderate SEA and OEA it help individuals to be and remain altruistic. This is consistent with the concept of optimality in which EI is beneficial at a certain level but becomes detrimental when it goes beyond the prescribed level.

It seems like the relationship between emotional and task processes is complex. However, a result that strongly emphasizes a general social sensitivity as a key to collective intelligence is found in the Woolley et al. (2010) study. Their experimental approach was to have groups do intelligence tests and then look for what factors have the strongest correlations with high results. Psychologists have repeatedly shown that a single

statistical factor—often called “general intelligence”—emerges from the correlations among people’s performance on a wide variety of cognitive tasks. However, no one has systematically examined whether a similar kind of “collective intelligence” exists for groups of people. In two studies with 699 people working in groups of two to five, they found converging evidence of a general collective intelligence factor that explains a group’s performance on a wide variety of tasks. This “*c* factor” was not strongly correlated with the average or maximum individual intelligence of group members. Instead, *c* was significantly correlated with the average social sensitivity of group members, the equality in distribution of conversational turn-taking, and the proportion of females in the group. First, there was a significant correlation between *c* and the average social sensitivity of group members, as measured by the “Reading the Mind in the Eyes” test. Second, *c* was negatively correlated with the variance in the number of speaking turns by group members, as measured by the sociometric badges worn by a subset of the groups. In other words, groups where a few people dominated the conversation were less collectively intelligent than those with a more even distribution of conversational turn-taking. Finally, *c* was positively and significantly correlated with the proportion of females in the group. However, this result appears to be largely mediated by social sensitivity, because (consistent with previous research) women in the sample scored better on the social sensitivity measure than men. In a regression analysis with the groups for which all three variables (social sensitivity, speaking turn variance, and percent female) were available, all had similar predictive power for *c*, although only social sensitivity reached statistical significance.

In their study, Shen, Lee, and Cheung (2012), look at the concept of “we-intention,” which refers to one’s perception of the group acting as a unit, in relation to the adoption and use of instant messaging. What is interesting in this study, in

relation to collective intelligence, is that it addresses an important area of research that has the potential to contribute significantly to our understanding of group adoption and use of technology in relation to knowledge integration. Collaboration enabled by different forms of social computing could greatly unleash the powers of collective wisdom and change the way people work and collaborate. In the current study, the use of instant messaging in mass collaboration was conceptualized and investigated as a group-referent intentional social action, and, accordingly, the concept of “we-intention” is employed as the dependent variable. The findings provided empirical evidence supporting the idea that cognitive, affective, and social factors jointly lead to the development of we-intention. One important feature of we-intention is the presence of collective commitment in joint cooperative action. If group members are collectively committed to performing an action, there will be publicly existing mutual interdependent promises among all the participants, and the promises involve putting oneself under an obligation to act. Therefore, the participants are socially committed to each other to perform their parts of the collective action. Another important feature of we-intention is that the joint action opportunities should be obtained with some non-zero probability. In this sense, the group member believes not merely that he/she performs his/her part of the group action, but does so with some probability that other members in this group will perform the activity and achieve the common goal together. Therefore, we-intention can be considered as one’s perception of the group acting as a coordinated unit where members in the group collectively accept the action and commit themselves to performing this behavior. Prior conceptual studies further emphasized that the beliefs for we-intention are purely subjective, indicating that a member can be the only agent in the group with we-intention. In this regard, we-

intention is often viewed and measured as an individual's subjective perception regarding the group behavior. According to the results of this study, anticipated emotions and social identity are the two most important determinants of establishing we-intention.

Also in relation to *group identity*, Randel and Jaussi (2003) examine demography and personal and social identity related to functional background to offer insights about individuals' performance in cross-functional teams. They considered both the interaction between identity and dissimilarity with other team members and the interaction between identity and membership in a team's minority or majority. In explaining the relationship between identity and an individual's performance as a cross-functional team member, minority/majority membership interacted significantly with identity, but the actual degree of dissimilarity did not. Their study showed that the negative effects of personal identity on performance as a team member are when a team member with a strong personal identity is in a team's functional minority. Their explanation for this finding is that members of a functional background minority tend to feel discouraged from engaging in behaviors that will benefit their team because they are perceived as weak performers (due to belonging to the minority) regardless of their course of action. Also, the self-serving behaviors of a strong personal identity may be increased for functional background minority members who may withhold cooperative behavior to serve self-interest. They also show that social identity was positively related to performance while personal identity and performance were negatively related. The authors conclude that developing social identification should be beneficial to individual performance in cross-functional teams.

COGNITIVE FACTORS IN INDIVIDUAL COORDINATION

In a study from 2007, Liang argues that the complexity of organizations has increased, but at the same time, the interacting agents (employees) have become more qualified (through education, technology, etc.), and leading qualified individuals is dramatically different from leading unskilled labor. In this new context, it is highly significant to recognize that all human thinking systems and human organizations are complex adaptive systems and that in such systems order and complexity co-exist. They learn, adapt, and evolve with their changing environment, like the behavior of any biological species in an ecological system. The intrinsic intelligence of the individuals drives the complex and nonlinear evolving dynamic and the collective intelligence they create as groups. Liang argues that the basic essential functions of leadership are to provide a direction, nurture a culture, and cultivate an "organizational soul." He claims that every individual is endowed with a certain degree of leadership value and quality. However, this intrinsic leadership quality in all the people who assume the role of *followers* is often suppressed by the structure of organizations. With the new evolving environment, where individuals are better informed and educated, a new advantage for any organization is, therefore, to elevate, optimize, and exploit this natural ability. A critical requirement for leading effectively in the new leadership paradigm is nurturing intense collective intelligence and mindful and supportive culture in the organization. The form of leadership to be adopted becomes more dependent on the types of activity or problem encountered, that is, more situational dependent. The leadership is highly dependent on the characteristics and expectations of the interacting agents, and the direct links between the intelligence of the leader and the intelligence of the followers is a critical success factor. The leader-follower gap will diminished

significantly. Thus, in the new leadership dynamic of an intelligent organization, the followers must be as much a part of the leadership process as possible and the way to enhance this development is to have effective and continuous communication.

A critical process in self-organizing individual coordination is knowledge identification, or expertise recognition, in groups. A study of the mechanisms for this is offered by Bunderson (2003). His paper focuses on the critical role of *team members' status cues* as indicators of their task expertise. The proposition is that while attributions of expertise in work groups will develop by both specific (i.e., task-relevant) and diffuse (i.e., social category) status cues, the strength of this association will be dependent on the type of cue as well as on characteristics of the group context. A multilevel test of these hypotheses in a sample of self-managed production teams in a Fortune 100 high-technology firm confirms that the alignment of intragroup influence with *specific* status cues is positively associated with group performance. Typically, knowledge and expertise are heterogeneously distributed within work groups such that some group members will be more expert in a particular group task than others, given differences in experience, training, education, or natural ability. Given this heterogeneity, work groups face the challenge of identifying their more expert members and give greater weight to their advice, suggestions, and opinions in solving problems and making decisions. We need to know what sorts of cues group members rely on and under what conditions they might rely on one type of cue versus another if we are to understand how expertise is recognized (or overlooked) in groups, and whether experts will have opportunities to influence group processes. Status characteristics theory provides a basic framework for

understanding how members' characteristics organize interaction in task groups. The theory begins with the assertion that power and prestige orders in task groups are driven by the "performance expectations" that the individuals hold for one another. That is, expectations about one's own and other group members' ability to contribute to accomplishing the task of the group. When individuals with different characteristics come together in a task group, the status cues influence the performance expectations they develop for each other. Status characteristics theory explicitly acknowledges two distinct categories of status cues. (1) Personal characteristics that provide information about an individual's competence in relation to a clearly defined and specifiable task are referred to as *specific status cues*. (2) Personal characteristics that are believed to provide information about an individual's general aptitude, which is presumed to affect his or her competence in a variety of different tasks, are referred to as *diffuse status cues*. The study by Bunderson (2003) showed that specific status cues more strongly predicted perceptions of expertise in decentralized, longer-tenured groups, whereas diffuse status cues more strongly predicted perceptions of expertise in centralized, shorter-tenured groups. Results suggested that the relationship between members' status cues and intragroup influence in these groups was mediated by perceived expertise. Finally, the groups in the sample performed better when intragroup influence was more closely aligned with specific status cues.

PROCESS AND ORGANIZATIONAL FACTORS

In a study from 2007, Hurley and Allen examined *group behaviors* that could be connected to process loss and process gain. In a factor analysis of 11 different factors, they got three constructs. The process loss behaviors grouped into one

externally oriented (directed outside the group interaction) and one internally oriented (directed into the group interaction) construct, where only the externally oriented was negatively related to performance. The authors analyzed the group work behaviors of 132 grade-school students to assess behavioral manifestations of group processes. Videotapes of students working together on a math-learning task were coded to quantify the incidence of micro-behaviors associated with process loss and process gain. After a literature review, the authors developed the following description of the two dimensions of process loss. (1) *Accountability*: Member attention is preoccupied with the possibility of external evaluation such that the threat of negative evaluation, or the preoccupation with a favorable evaluation from an external evaluator, is likely to affect effort or contribution. In the group setting, if there is no information that will be available about one's work or no accountability or consequence likely to follow from one's efforts, one will likely loaf, reduce level of effort, or not make a high-quality contribution to the group product. The reverse is also true. (2) *Task-Hindering Group Dynamics*: These are disruptions or inadequacies in the dynamics of group functioning. This entails difficulties in communication between group members, lack of consensus in approach to the task, disagreements or problems tied to the fair distribution of various members' contributions, lack of coherence in the distribution of labor, lack of receptivity to certain members' input, and time wasted in faulty, unhelpful, or irrelevant input. This also includes members working independently during group-oriented tasks. It is interesting that the study does not find a correlation between the task-hindering group dynamics and performance (whereas the accountability factor is negatively correlated with performance). It seems plausible that process loss behaviors directed into the group interaction have a more complex relationship with performance

outcomes than behaviors directed outside the group. An example of interpretation could be that awkward trying, as compared with not trying at all, might result in a positive relationship with performance insofar as it involves a certain level of engagement.

Another essential factor when we look at individual contributions to collective intelligence will, of course, be *leadership*. In a study from 2013, Lorinkova et al. integrate theories from the leadership and team development literatures to resolve ambiguity regarding the relative benefits of empowering versus directive leadership in teams, by focusing on their influence on team development processes over time. Empirical results based on longitudinal performance data from 60 teams suggest that teams led by a directive leader initially outperform those led by an empowering leader. However, despite lower early performance, teams led by an empowering leader experience higher performance improvement over time because of higher levels of team learning, coordination, empowerment, and mental model development. Team leadership research has concentrated on the leader behaviors that promote, develop, and maintain team performance. Two distinct approaches—empowering and directive leadership—have assumed special importance. Empowering leadership involves sharing power with subordinates and raising their level of autonomy and responsibility, and it manifests through specific behaviors such as encouraging subordinates to express opinions and ideas, promoting collaborative decision-making, and supporting information sharing and teamwork. Empowering leadership tends to create psychological ownership of a task, heightened efficacy and commitment, and higher levels of coordination and collective information processing. Directive leadership, on the other

hand, is associated with a leader's positional power and is characterized by behaviors aimed at actively structuring subordinates' work through providing clear directions and expectations regarding compliance with instructions. Directive leaders help followers resolve task and role ambiguity and provide external monitoring and feedback on their performance, reducing process loss and allowing the team to execute decisions more quickly. Although researchers and the practitioner-oriented literature have advocated empowering over directive leadership, the empirical evidence has not fully supported this view, and it is not clear that empowering leadership is better for enhancing team performance. Each style tends to enhance follower performance because both directive and empowering leaders are actively attempting to improve team effectiveness through thoughtful, planned behaviors. Empowering leadership tends to benefit interdependent teams by establishing participative and collaborative norms among members, encouraging them to contribute ideas, decide on optimal courses of action, and take responsibility for team performance. At team level, the goal of empowering leadership is to develop a team's capacity to perform autonomously. Empowering leadership requires leaders to invest more trust in their followers by allowing high levels of discretion and decision-making authority to pass into the followers' hands. Together, these types of behaviors tend to lead to positive individual and work-group outcomes across contexts (e.g., Pearce et al., 2003; Yukl, 1998). For example, Zhang and Bartol (2010) recently provided evidence that empowering leadership enhances employee creativity through its effects on employee psychological empowerment, intrinsic motivation, and creative process engagement. Similarly, Ahearne, Mathieu, and Rapp (2005) found a positive relationship between leader empowering behaviors and followers' job performance attributable to increased levels of self-efficacy and adaptability. However, a directive

approach (also called autocratic leadership style in Vroom and Jago, 1988, "tough leadership style" in McIntyre and Salas, 1995, focuses on behaviors related to giving detailed directions, expecting subordinates to follow those instructions, and making decisions with limited subordinate input. Research suggests that a superiors' "directiveness" can make task accomplishment easier for followers by providing them with specific, role-relevant directions and helping them focus their efforts toward their individual tasks (Kahai et al., 2004). Also, directive leadership helps everyone to be better aware of his/her own role and the availability of role resources reducing ambiguity about what each person does and establishing clear rules for behavior (e.g., Katzenbach & Smith, 1993). For example, research has shown that directive leadership can lead to improved patient care through the assignment of specific actions for handling an emergency (Yun et al., 2005). This contrasts with empowering leadership in which the higher degree of freedom and discretion granted to team members allows more potential paths toward attaining a goal, potentially decreasing task and role clarity.

Above were examples of group behavior and leadership relating to individual coordination of teams. Perhaps the most direct behavior of individuals, relating to their coordination of teams as systems, is what has been called *self-leadership*. That is, individuals leading their own actions in group work. Boone et al. (2005) discuss this in relation to what is called individuals' *internal locus of control (LOC)*. Locus of control is an important and well-documented personality trait that refers to individual differences in a generalized belief in internal versus external control of reinforcement (in the context of a stimulus and response). People with an internal locus of control see themselves as active agents. They feel that they are masters of their fates, and they trust in their capacity to

influence the environment. Conversely, those with an external locus of control see themselves as relatively passive agents, believing that the events in their lives are due to uncontrollable forces. In their study, Boone et al. found that groups with high levels of internal LOC performed better without a leader if the members shared this characteristic. That is, they had low LOC heterogeneity. Groups with external LOC needed a leader to perform well. Information acquisition mediated the relationship with performance. Control perceptions appear to be very salient in explaining effective management. Specifically, research into the relationship between CEO locus of control and organizational performance consistently shows that firms led by CEOs who are internals perform better than firms headed by those who are externals, both in the short and long run (Boone, De Brabander & Hellemans, 2000; Boone, De Brabander, & Van Witteloostuijn, 1996; Miller & Toulouse, 1986). Interesting for this study is that locus of control has been related in numerous experiments with cognitive activities such as attention and alertness, and information search and assimilation. Specifically, in reviewing the findings on cognitive capacities of internals versus externals, internals acquire more information, make more attempts at acquiring it, are better at retaining it, they are less satisfied with the amount of information they possess, are better at utilizing information and devising rules to process it, and generally pay more attention to relevant cues in the situation. All this provides support for the validity of the locus-of-control construct as it is indicative of a basic striving of internals to engage actively in seeking relevant cues in their environments to determine and make sense out of their positions and to guide or adapt their behavior accordingly. Also, personality research makes it clear that individuals with an internal locus of control have larger information-processing capacities than their counterparts with an external locus of control (Govindarajan, 1988,

1989), and, therefore, they will gather more information and utilize it better in decision-making. A team consisting predominantly of internals is, therefore, more likely to develop a collective team-level sense of potency. Such a team, compared to a team consisting of externals, will believe that the group can effectively influence team processes and outcomes, such as the quality of decisions. The feeling of collective potency will stimulate such internal teams to collect more information to increase team effectiveness. The higher information-processing capacity of teams predominantly consisting of internals will reinforce such intent and efforts.

Another perspective of self-leadership is *discretionary behavior* in organizations. It has long been recognized that organizations desire employees who engage in cooperative and helpful behavior that goes beyond formal job requirements. Organ defined this behavior as “*discretionary*, not directly or explicitly recognized by the formal reward system, and that in the aggregate promotes the effective functioning of the organization” (Organ, 1988). Multiple terms have been used to describe such behavior (e.g., prosocial behavior; contextual performance; organizational spontaneity). Smith, Organ, and Near (1983) and Bateman and Organ (1983) offered the construct of *organizational citizenship behavior* (OCB). OCB has been linked to a broad set of desirable outcomes such as job satisfaction, organizational commitment, leader behavior, job performance (Podsakoff et al., 2000), and group or organizational effectiveness (e.g., Koys, 2001; Podsakoff, Ahearne, & MacKenzie, 1997). In all, the results of this growing literature seem to support Organ’s original contention that OCB promotes the functioning of organizations. Although this body of work is expansive, most research has examined OCB as a purely individual-level phenomenon within work organizations

(Podsakoff et al., 2000). However, most constructs relevant to organizational behavior are inherently multilevel. In an article, Bommer and Dierdorff (2007) explore multilevel relationships between group-level OCB, individual-level OCB, and work performance. Their hypothesis is that group-level OCB moderates the relationship between individual-level OCB and job performance. Results based on 100 work groups in a manufacturing firm indicate that group-level OCB significantly moderated the relationship between individual-level OCB and job performance. When comparing contexts in which group-level OCB was rare with those in which it was prevalent, they found that high individual-level OCB yielded greater significant increases in job performance ratings when group-level OCB was rare. That is under conditions of strong group-level OCB, an individual's display of OCB is likely to be less distinctive and contribute less to ratings of job performance. Because group-level OCB involves the behavior of an entire work group, it is very likely to foster what Ehrhart and Naumann (2004) described as group-level "OCB norms." Put simply, the value of a person's citizenship relative to his or her job performance is greater when performed in the context of rarity rather than prevalence. These findings strongly highlight how context serves as an influential backdrop to work behavior and how milieu often changes the magnitude of well-established relationships.

STIMULATION OF INDIVIDUAL COORDINATION

As a general introduction to this section, I will use a meta-analysis by Salas et al. (2008) conducted to answer the question: "Does Team Training Improve Team Performance?" Disparate effect sizes across primary studies have made it difficult to determine the true strength of the relationships

between team training techniques and team outcomes. Several meta-analytic integrations were conducted to examine this relationship. Specifically, they assessed the relative effectiveness of interventions on team cognitive, affective, process, and performance outcomes. Training content, team membership stability, and team size were investigated as potential moderators of the relationship between team training and outcomes. In total, their database consisted of 93 effect sizes representing 2,650 teams. The results suggested that moderate, positive relationships exist between team training interventions and each of the outcome types. The findings of moderator analyses indicated that training content, team membership stability, and team size moderate the effectiveness of the interventions. Their conclusion was that team training interventions are viable approaches organizations can take in order to enhance team outcomes. They are useful for improving cognitive outcomes, affective outcomes, teamwork processes, and performance outcomes.

Looking at the Cooren (2004) analysis, we saw an extension of Weick and Roberts (1993) concept *collective mind* (collective intelligence found in patterns of behavior) into conversations, that is, people verbally trying to offer solutions and make decisions collectively. As we saw, *coproducing, amending, and completing utterances* amounts to contributing to the joint solutions and situations collectively constructed by the board meeting. In other words, a form of collective intelligence can be identified in the board meeting to the extent that the managers' exchanges contribute to the construction of these joint situations and solutions, to which the verbal interactions are supposed to be subordinated. Hence, the act of knowing is here not reduced to a mental process of an individual but is described as a communicative process between participants. Even if such a communicative process in a meeting is locally produced (or situated), what Cooren calls translocalization shows that the board meeting is,

in fact, a place in which several portions of the organization are represented, made present, by the members, in their process of translocalization. Cooren discusses this as an area in which so-called “high-efficiency organizations” need to become more “reliable organizations.” For organizations to become more reliable, the translocalization is a key in locally (for example a meeting) re-presenting collectively what is happening in the organizations and their environment. This would in most organizations imply a shift from focusing on decision-making (as the objective of meetings) to sense-making. Once the situation makes sense, that is, once the decisional premises have been collectively established and acknowledged, decisions follow and appear relatively obvious. Although this does not mean that what appears to make sense always gives the key to sound decisions; focusing on collective sense-making will highlight the process by which (wrong or right) decisions are made.

The general result of the Moore and Mamiseisvhili (2012) study is support for emotional intelligence (EI) being related to group cohesion. The results of the study signal the importance of awareness of own emotions in relation to cohesion. Awareness of own emotions is the ability of an individual to know his or her feelings in the moment, and having the ability to reflect, discuss, and disclose those to others. Wolff, Pescosolido, and Druskat (2002) found that individuals with high awareness of emotions communicate more effectively in teams and have less intense emotional reactions. Helping employees and managers become more self-aware of their strengths, weaknesses, and their emotions should be an important priority in organizations. Collaborative learning should allow individuals to provide feedback and become more self-aware. The results of the study also support the hypothesis that a team with higher overall EI is significantly more cohesive than groups with lower

overall EI. Although the groups with higher maximum EI scores were more cohesive than the groups with lower maximum EI scores, the authors argue that the relationship between minimum EI scores and group cohesion is more meaningful. They found that groups that included an individual with lower minimum scores of total EI were significantly less cohesive than groups that contained members with higher minimum scores of EI. This could be explained by the theory of emotional contagion (Barsade, 2002). The idea is that emotions or moods can be contagious. Although many clichés exist about teams being only as strong as their weakest member is, this study supports the claim that a weak member cannot be ignored when exploring EI and cohesion.

The Stubbs (2005) dissertation also supports the idea of working with development of emotional intelligence in organizations. Stubbs suggests primarily the development of emotionally competent managers. Her research shows that individual (leader) EI affects team performance through the development of emotionally competent group norms. Considering these findings, corporations should actively try to develop the emotional intelligence of their managers and leaders. This could be accomplished through multiple modalities including, for example, 360-degree feedback and executive coaching, along with employing leaders with developed emotional competence. According to Stubbs, focus should be on the establishment of organizational leaders to foster an emotionally competent environment throughout the organization. If the president of an organization were emotionally competent, that would develop emotionally competent group norms on the team of executive managers. In turn, each individual on the executive management team would influence the development of ECGNs (emotional competent

group norms) on the teams they lead. This cycle would continue through a hierarchical organization, according to Stubbs.

Hess and Bagicalup (2011) state that little research has been contributed on how the behaviors associated with emotional intelligence may be practically applied to enhance both individual and group decision-making. The purpose of their paper is therefore to *identify practical approaches for applying emotional intelligence in the decision-making process*. The acknowledgment of individual emotions is critical in determining not only the motivations behind decisions but also the impact of those decisions on others. Decision-makers who understand the emotions of others may utilize that perceptivity to head off potential negative outcomes by addressing those emotional issues in advance of the decision. Likewise, decision-makers who perceive and understand their emotions will be much more effective in managing those emotions in the decision-making process. The emotional intelligence skills in decision-making may be categorized as those more related to the individual (self-awareness and self-management), and those more attributable to the individual's relationship and interaction with others (social awareness and relationship management). Applying the skills of self-awareness and self-management to decision-making situations is a process that can be learned. The following questions and observations can serve as a practical guide for individuals and organizational leaders in decision-making circumstances. From Hess and Bagicalup, 2011:

1) *Are decision-makers aware of their decision-making skills and styles?* Is there a tendency to reach first for the emotional elements of a decision circumstance, or conversely, to reach for the rational analysis components? Emotionally intelligent decision-makers will make an honest self-assessment of skills and

styles, noting the differences in their behaviors and abilities as compared to others.

- 2) *Would others describe decision-makers as inclusive or exclusive in decision-making processes?* The leadership and decision-making styles as described by Vroom and Yetton (1973) are useful here. These authors described a range of behaviors beginning with the pure autocratic style, to partial inclusion and pure delegation. While decision-makers may view themselves as more democratic or participatory, the more critical aspect is the perception of others. While it may not be appropriate to be inclusive in every decision, the emotional intelligence function suggests it is important to communicate to others when and why inclusive or exclusive methodologies are utilized.
- 3) *Are decision-makers confident in their decision-making skills?* Fear makes individuals second-guess themselves and abandon support for efforts that have gone even slightly off track. Emotionally intelligent decision-makers must exude confidence in their decision-making style. Being self-aware also implies acknowledging one's weaknesses and having the confidence to recognize the strengths of others in decision-making. Self-awareness also includes the skill of recognizing the impact of one's styles and behaviors on others.
- 4) *Are decision-makers merely focused on their interests or are they truly interested in achieving the best decision results?* Emotionally intelligent decision-makers are characterized by their ability to suppress their desires and interests for the common good.
- 5) *Are decision-makers overly focused on the desire for a speedy result?* Bazerman and Malhorta (2006) noted that time pressures often lead decision-makers to bad judgments. Patience is pivotal in achieving the desired decision outcome.

How can a decision-making process be utilized to build trust, not only for decision-makers but also among all the appropriate constituents? Mayer and Caruso (2002) noted that leaders high in emotional intelligence will build social fabric within an organization, as well as between the organization and those it serves. Interpreted in the decision-making environment, this social fabric is best described as furthering and honoring the culture of the organization. Accordingly, emotionally intelligent decisions are those that are grounded in the culture of the organization.

- 6) Are decision-makers willing to adapt to new decision-making processes rather than relying on the entrenched processes of the past?

When the need for a new decision-making process arises, those who can self-manage and correct course earn the trust of those involved in the process. The honest acknowledgment of a need to break with the practices of the past is critical to building self confidence, as well as developing the relationships necessary to affect a positive decision result (Huy, 1999).

- 7) Are decision-makers willing to quickly admit to and correct misjudgments? The ability to openly admit to mistakes is important to both self-management and relationship management. Mistakes make emotionally intelligent human beings stronger and give them the opportunity to connect with others in honesty and humility.

- 8) Are decision-makers willing to delegate decision-making authority appropriately?

Tannenbaum and Schmidt (1958) developed a continuum of control and decision-making shared between leaders and followers. At all points on their continuum, both the leader and the followers have some control. The amount of control each party has depends on the amount that the followers can assume. The

leader begins with most of the control over decision-making and gradually passes this over to the followers, as they develop their capability, commitment, and maturity.

- 9) Are decision-makers willing to accept the consequences of having delegated or shared the decision-making authority? When decision-making is delegated and things go wrong, the true test of emotional intelligence arises. The emotional intelligence skill applied here is for both the person delegating the decision and the decision-maker to acknowledge and learn from the mistake. Additionally, emotionally intelligent decision-makers share credit for good decisions and accept responsibility for bad decisions even though they may not have agreed with the decision.

In assessing and developing social awareness and relationship management skills, decision-makers might consider the following questions and practical observations to enhance decision-making (according to Hess and Bagicalup, 2011):

- 1) *What individuals, groups, or constituents will be most affected by the decision?* Social awareness implies decision-makers have adequately contemplated the impact and consequences of a decision before it is made. This emotional intelligence skill requires decision-makers to play out scenarios of decisions to determine both their short- and long-term consequences and effects (Huy, 1999).
- 2) *How should those impacted by the decision be involved in the decision-making process?* Those impacted by a decision will perceive the change more positively if they are involved in the decision-making process. This involvement may range from active participation in the contemplation of decision

- options to commenting before a decision is finalized.
- 3) *What decision-making processes are most appropriate given the culture of the organization?* Being socially aware requires decision-makers to assess the culture of the organization to determine appropriate actions. For example, if the culture of the organization is team oriented and participatory in nature, it would be important to design decision-making processes consistent with that culture.
 - 4) *How will the decision and decision-making process be viewed in retrospect?* Emotionally intelligent decision-making requires looking forward and backward simultaneously. Viewing actions from a historical perspective enables decision-makers to assess the impact of current decisions through the eyes of constituents. Reliving past decisions through the lens of their impact also assists emotionally intelligent decision-makers in playing out the future of currently contemplated actions.
 - 5) Are decisions viewed as a means of developing or furthering relationships with those with whom decision-makers work? Relationships are based on communication and trust, and emotionally intelligent individuals view every decision-making circumstance as an opportunity to develop or improve the relationship with others.
 - 6) *How do decision-makers communicate with others engaged in the decision-making process?* This aspect of relationship management requires a regular and consistent method of communication that reinforces the role of each person in the decision-making process. When a decision has been delegated, it remains critical to support that delegation in all communications.
 - 7) *What are the decision-makers' attributes in managing conflict?* Emotional intelligence is exhibited in conflict settings by seeking first to

understand the position and feelings of the other person (Mayer and Caruso, 2002). Thus, in circumstances of conflict, emotionally intelligent decision-makers listen more than they speak and seek opportunities to learn the opinions of others. Being direct about conflicting views is important to demonstrate honesty, and exhibiting compassion in moments of tension develops the trust necessary to foster long-term relationships. Also, the emotionally intelligent response in moments of conflict requires an examination of one's own emotions. It is possible to exhibit self-control only if one understands the origins of experienced emotions. Emotionally intelligent decision-makers manage volatility by expressing compassion while exhibiting and furthering the culture of the organization in the decision-making process (Huy, 1999).

In their study of *social identity and functional background*, the Randell and Jaussi (2003) findings imply that promoting functional background and social identification in a cross-functional team can be beneficial for encouraging individuals to perform more effectively as team members. Recognition of the functional backgrounds of outstanding team members should achieve individual-level performance gains when social identification (as measured here as feeling successful when functionally similar others attain goals) is strong. Furthermore, the research suggests that managers who seek to avoid the negative performance implications of a team member's strong personal identity should consider whether the individual is in the functional background minority or not. The negative effects of personal identity on performance as a team member become stronger when a team member with a strong personal identity is in a team's functional minority. To avoid the low-performance outcomes associated with this,

managers should not only consider minority membership but also make efforts to assess their functional personal identities before placing them on a team. If faced with an individual with a strong functional personal identity who will be in the minority, managers could consider adding members to the team from similar functions so that the focal individual will no longer be in the functional minority. Alternatively, managers could consider not assigning individuals with strong functional personal identities to teams in which their functional background would be in the minority.

In the Bunderson (2003) study, the performance results are consistent with a knowledge-processing or group-learning model of group effectiveness. In this "emerging conceptualization of groups" (Hinsz, Tindale, and Vollrath, 1997), group processes that facilitate the optimal utilization of members' expertise, knowledge, or information are highlighted as critical for effective group functioning, particularly in groups that solve problems or make decisions. The present study elaborates this view of group effectiveness by focusing on the role of members' status cues as expertise signals, by demonstrating the importance of group context in facilitating or impeding expertise recognition and utilization, and by demonstrating that reliance on more diagnostic cues is associated with group effectiveness. It is important to note, however, that recognized expertise was not the only path to influence in these groups. An individual's formal role assignment as a coordinator also significantly predicted intragroup influence, and the relationship between formal role assignment and intragroup influence was not mediated by perceived expertise. The results of this study, therefore, support two routes to influence in task groups: (1) influence through recognized expertise signaled by one's specific and diffuse status cues

and (2) influence through legitimate authority signaled by one's formal role assignment. The findings from this research suggest that for groups, in which individuals have a shared interest in accomplishing clearly defined tasks, it is in the interest of each member that all other members grant deference (i.e., are prepared to follow him/her) based on expectations for task performance rather than on another criterion. Therefore, strong norms emerge that make expertise the legitimate basis for influence and that delegitimize (and sanction) those who would seek dominance or influence independent of expertise claims. This is not to suggest that members of such groups will shun political maneuvering and dominance moves but, rather, that these political behaviors will tend to be framed in terms of expertise claims and expertise signals (i.e., specific and diffuse status cues) rather than around naked dominance plays.

In their study, Lorinkova et al. (2013) compare two distinctive leadership styles: empowering and directive. Doing so provides insight into both when and why leadership approaches are most effective in teams and contributes to debate as to the limits and benefits of empowerment. Conceptually, their findings confirm the existing notion about the positive influence of empowering leadership found in the literature for individual performance and long-standing top management teams and extend them to action and project teams that undergo team development before reaching their full potential. However, by demonstrating that empowering leadership comes at an initial performance cost, they highlight an important boundary condition to empowering styles that may help explain some of the inconsistent or weaker effects on performance described in the literature. They also extend the empowering leadership literature to consider the critical role of team developmental phases, demonstrating that the

influence of leadership manifests directly through emergent team processes and states. Empowering leaders encourage team members to engage in role exchanges and collective investigation in the early role compilation phase of development, in which they learn about their task environment and each other's areas of expertise to develop team mental models of how to integrate their efforts, gain collective efficacy and commitment through psychological empowerment, and foster routines to coordinate their behaviors. This time-consuming process puts them at a performance disadvantage compared to teams with directive leaders (who immediately focus on task performance) that rely on their leaders to provide explicit within-team coordination. However, empowered teams eventually overtake teams with directive leaders as the former enter the team-compilation phase of development and adaptation, in which teams increasingly rely on their routinized processes and shared cognitions to coordinate their efforts and knowledge smoothly and continuously improve their performance. The current conceptualization of follower readiness tends to focus on the maturity, commitment, and skill level of individual followers but to neglect the critical team processes and emergent states that allow empowering leadership to be effective at the team level. Teams with diverse expertise and working interdependently on complex tasks require an investment in time and leader support to develop the behavioral processes, such as learning and coordination, as well as the shared cognitive understanding to perform and adapt effectively. This investment, made through the empowerment of team members during role compilation, takes longer to pay off but is critical for such teams' long-term success. However, because directive leaders limit the emergence of these states and processes, these results also raise questions about the central tenet of situational leadership theory that teams with an initial directive leader will eventually become ready for

that leader to switch to an empowering style. Some managerial implications of this could be that for teams with short-term or emergent engagements and teams facing emergency situations (e.g., surgical, police, military, and flight teams), a directive style may be most appropriate, as teams must be able to perform immediately at a high level and cannot afford the performance delays and learning errors associated with empowered teams. However, when teams have an extended timeline, as do project or software development teams, or must be able to adapt to complex and changing environments over time, an initial and continuing empowering leadership style may be most appropriate, as it encourages the development of shared cognitive structures, routines for learning and coordination, and feelings of collective competence and commitment during the role-compilation phase that set the stage for higher long-term performance. However, it is important that managers do not misinterpret these findings to conclude that a directive leadership style is beneficial early, but that one should switch to an empowering style as the team progress to the team-compilation phase of development. Although there may be some advantage to employing a combination of the two leadership approaches, our results suggest that the benefits of empowering leadership in teams tended to manifest because team members initially engaged in role identification and learning processes during the role-compilation phase. Empowered teams, therefore, may not be able to reap the benefits of improved performance over time without first suffering the initial performance delays.

The Boone et al. (2005) study of locus-of-control research points to some interesting conclusions on teams and leadership. First, the well-documented fact that internal individuals are better at information processing than external individuals appears to be true at the group level of analysis as

well. Specifically, adding internals to a team is likely to increase the team's information-processing capacity, resulting in more information acquisition behavior and, thus, better team performance. Second, the findings show that a leader might serve as a substitute for the relatively low information-processing capacity of an external team. External teams clearly gain effectiveness from having leaders. These findings have interesting implications for managerial practice because they suggest the importance of fitting group processes and structures with the personality distribution within a team. *There does not seem to be a best way to structure a team.* On locus of control, it is important to create within-group settings that naturally fit with the needs and capacities associated with the deep-level characteristics of team members. When members have an internal locus of control, self-organization is likely to lead to superior team performance. If, however, most members have an external locus of control, appointing a leader to guide team members seems to be very important. Thus, an important road to improved team effectiveness might be the design of what could be called "natural" team configurations—natural in the sense that externals like to work in structured situations with leadership, while internals prefer uncertainty and individual agency.

Finally, with his paper *Leadership for collective thinking in the workplace*, Martin Ringer (2007) intends to raise awareness in organizations of the ubiquitous nature of thinking in teams and informal groups, and provide the reader with conceptual tools for understanding the subtle dynamics of "team-level" thinking. He wants to offer some practical suggestions on how to increase the quality of collective thinking in workplaces. It is proposed that many essential influences on collective thinking exist outside the usual limits of awareness—that is, they occur as

unconscious processes—and, therefore, developing powerful collective thinking requires that attention is paid to symbolic, non-rational, and intuitive patterns in teams and organizations. The article springs from a belief that in many organizations there is considerable room for improvement in the way that we utilize the intelligence of the team or group—that is the potential for "collective thinking." The main purpose of thinking together in organizations is to enable coordinated action that contributes to the organization's achieving its purpose. However, there seems to be a relatively widespread blindness toward the importance of high-quality collective thinking for businesses. We value intelligent individuals but seem to lack ways of understanding and working with thinking in the team-as-a-whole (Albrecht, 2003; Bohm, 1996; Isaacs, 1999). The size and complexity of most organizations mean that the knowledge required to run an effective enterprise is too great to be held in one brain. Hence, effective business leadership and management requires the pooling of knowledge and "thinking skills" from various people. Effective collaborative thinking is needed to distribute the knowledge in an organization and subsequently to work with that knowledge to transform it into effective business understanding and decisions. Four principles at help to provide practical guidance to leaders for building the quality of collective thinking in organizations. They are as follows:

- 1) Collective thinking in organizations needs to be focused through a shared understanding that the team will work toward an agreed purpose. Facilitating this focus is a key leadership role.
- 2) Every individual needs to be able to manage his or her emotional and psychological world adequately to retain access to his/her communicational, relational, and work skills that enable that person to think together with others in the team. Team leaders especially

need to retain their emotional equilibrium to be effective in their leadership role.

- 3) Relationships, as well as groups, provide a “thinking space” and so the quality of relationship has a direct impact on the quality of “thinking-together.” Furthermore, the quality of mood, tone, and expectation in any group or team has a significant impact on the quality of thinking together in that team.
- 4) The responsibility for building and maintaining a thinking space in the team needs to be shared by members of the team and not left to the formal leader or facilitator.

Ringer emphasizes the role of the individual in sharing the responsibility of creating a “thinking space.” A role in which all individuals (employees) needs to manage his or her emotional and psychological world adequately. Ringer also points out the issue that we lack the ability to “see” the collective thinking processes and their quality. Until such instruments are available, he compiles a list of indicators of poor quality collective thinking (from Ringer, 2007):

- 1) The atmosphere of a team does not feel safe enough for most participants to think and speak freely, so even though individual team members may be thinking exceptionally useful thoughts, these ideas are not made available to the rest of the team.
- 2) Patterns of assumptions, norms, and beliefs prevalent in the culture of the organization prevent some topics from being addressed, questioned, or introduced into the conversation, but nobody is consciously aware that these patterns exist in the team or organization.
- 3) The leader of a team attempts to create open debate in a team but inadvertently signals through his/her actions over time that there is not really space for ideas that are too different from his/hers. Often, the team leader is not

aware that this is what he/she is doing and so it is very difficult for team members to address the problem. Instead, team members “go through the motions” and let the team leader keep believing that he/she is facilitating a great collaborative conversation.

- 4) A team unknowingly becomes locked into a type of thinking that is not the most useful for the situation. For example, convergent thinking is required for decision-making. That is, when an adequate number of options have already been identified, the number of ideas needs to be reduced to the one that is finally chosen. On the other hand, divergent thinking is required when a team is seeking to be creative in the search for more options. Teams seldom specify what kind of thinking they need to be conducting. This lack of clarity can lead to confusion and low-quality collective thinking.
- 5) One or more team members consistently act in ways that create a team atmosphere in which collective thinking is almost impossible. Persistent patterns of many different types of behavior in a team can lead to a loss of quality of the “thinking space.” Examples include hostility, vanity, boasting about oneself, being constantly “hurt” by what others say, being dogmatic, being opinionated/strident, and questioning everything.
- 6) Team-level awareness is very low. Individual team members will have one-on-one conversations in the team without being aware that everything they say and do in the context of the team affects the whole team. In the normal functioning of a team, all team members witness all interactions between others and use that interaction as information to predict how they themselves will fare when they actively participate. Also, team leaders usually underestimate the psychological and emotional power of what they say and do. In general, team members notice a team leader’s

every move and these “data” have a powerful influence on “how we do things around here”—that is, team culture.

- 7) Feelings are discounted or over-emphasized. There is now ample research showing that thinking is integrated with feeling and that complete denial of feelings diminishes the quality of thinking. In any team, much activity occurs at an intuitive level—resulting in feelings, flashes of intuition, and half-thought thoughts, but if no team member gives voice to any of this material, there is a failure to harness the richness of this collective non-rational effort. On the other hand, being swamped by strong feelings can also drown out thinking. That is, if a team focuses excessively on the feelings associated with a topic, the thinking can be lost. To help build a climate in a team where thinking and feeling are balanced and integrated, the team leader needs to be emotionally competent. Participants will look to the team leader to signal “what is OK” in terms of balance between thinking and feeling, and if the team leader is not aware of the unbalanced nature of a conversation, it can be difficult for team members to break the pattern themselves.
- 8) Curiosity is absent and even replaced by blame and attack. That is, team members show no real interest in the impact that they themselves are having on the interaction and instead blame others for anything that goes wrong. The way in which a team leader discourages blaming behavior and encourages curiosity has a major impact on how the team, as a whole, moves between being curious or blaming.
- 9) Conversations are driven by time restraints so that the criterion for the success of conversations is that they have been “finished.” This results in forcing closure and curtailing potentially useful input. Furthermore, the anxiety that is generated by

being hurried along diminishes the quality of the thinking that does occur.

Ringer also discusses the appearance of a team that is effectively thinking together. “It is possible to obtain cues through observation that indicate when the quality of collective thinking is high.

- Participants will probably seem to be acting as if something interesting, challenging, or engaging is going on.
- It will appear as though most people present have a positive expectation that it is useful to take part in the discussion.
- Team members will vary over time in the degree to which they are actively involved, but on average there will be a purposeful sense of industry about the team (Bion, 1961).
- Conversations will probably occur in intense bursts, sometimes interspersed with silences that may feel full and rich because participants will be immersed in intensive thinking about the topic under discussion.
- The conversation will not always seem to be logical in that it may weave around the main topic of discussion, but most of these apparent diversions will end up adding something to the overall exploration.
- There are likely to be disagreements as team members assert their opinions strongly and even passionately.
- As time progresses, coherent patterns will start to emerge in the conversation, and some of these patterns may even evolve into decisions, commitment to action, or an agreement that there is emerging understanding in the team about something that has previously eluded understanding.
- If we could look a little deeper and see what is going on in people’s heads and hearts, we

might find out that most people present perceive the team to have a shared understanding of what is being discussed and why.

- They will have a positive expectation that what they say will at least be held in mind by others present and will be given some consideration, even if their ideas are eventually discarded.
- They will be reasonably confident that they will not be personally attacked.
- They will be largely curious about what others say and will be prepared to “play” with ideas; that is, let their minds free up and go in unexpected directions that are not necessarily logically related to the topic under discussion, although they will still hold in mind the intention of the discussion.
- They will also be curious about what is going on for themselves. For example, at times, each person in the group will reflect (usually silently) on what is going on in his or her internal world. That is, participants will at times quietly reflect on how engaged, how excited, how fearful they are. Often, they will take the next step in the chain of curiosity which is to ask themselves questions such as “What is it about me that has me thinking, feeling, and doing what I am right now in this group?” (Argyris, 1993; Isaacs, 1999; Schön, 1983)

The kind of curiosity that keeps a thinking space in good shape is two directional: Participants are curious about what is going on in the group—that is “outwards” curiosity, and at the same time they will be curious about what is going on in or with themselves and their own functioning—that is “inward” curiosity. Effective collective thinking will sound, look, and feel different depending on the nature of the topic, organizational culture, setting, and level of urgency; therefore, it is not possible to

describe any one ideal way of thinking together. What is more, a group that is thinking together effectively is likely to experience quite wide swings in the feeling and interactions in the group. Effective thinking in groups and teams becomes evident in patterns of interaction that need to be observed over time, rather than being evident in any one “snapshot” of team interaction. Hence, the overall question that we need to ask when we are assessing the effectiveness of the thinking in a team-level discussion is “Over the period of this meeting/interaction, how well is this group of people making use of the intellectual resources and knowledge that exist in this team?” (Ringer, 2007).

Ringer ends his paper with some practical suggestions for leaders. According to him, there is no magic wand to create effective collective thinking. Otherwise, it would already be well and widely known throughout the business community. However, those who are prepared to work on their skills and knowledge can do some things to improve their ability to lead teams to be more effective with collective thinking.

- 1) Base your leadership and facilitation on a coherent and operational conceptual model of effective collective thinking. That is, learn the science and psychology of team-level thinking to give yourself tools for thinking about, talking about, and working with this phenomenon.
- 2) Understand that team-level thinking occurs in addition to high-quality individual thinking. Collective thinking is a phenomenon different from but related to individual thinking; it follows different rules and requires some additional understandings.
- 3) Teach yourself to pay attention to the team as a whole and not just to individuals or relationships in the team.
- 4) Build on your intuitive functioning and your awareness of subtleties in human interaction

and team-as-a-whole interactions. Both feelings and unconscious processes have a huge impact on collective thinking and, therefore, understanding the hidden dynamics of teams is a pre-requisite to working better with team-level thinking.

- 5) Improve your familiarity with your internal world and habitual patterns of perceiving, believing, and behaving. Being familiar with your own responses to the world improves your chances of noticing and making sense of what is going on around you.
- 6) Build an organization-wide that is prepared to address the quality of collective thinking. Once it can be spoken about it is possible to deal with many patterns of interaction that reduce the quality of team-level thinking.

KNOWLEDGE GAPS AND NEED OF FUTURE RESEARCH

If nothing else, this literature review has confirmed that we will become more dependent on how we integrate our knowledge. The underlying force driving the development is the increasing knowledge base, which leads to increased complexity, which in turn leads to organizations becoming more dependent on the logic of integrating brains, rather than muscles.

RESEARCH ON DISCRETIONARY BEHAVIOR

Collective intelligence could be called just that, the integration of individual brains or intelligence. In this study, we focus on this process at what we call the micro-system level, that is, the process between identifiable individuals in a specific situation. However, the key role in organizations striving to develop collective intelligence will be played by the individuals, the employees, rather than the micro-systems or the organizations. There are two reasons for this.

First, only individuals can govern the social processes of the micro-systems. The advantage of the micro-system perspective, and one of the overall findings of this report, is that it shows how dependent the process of cognitive coordination is of its parallel, social, process. It is not possible to talk about “integration of knowledge” at micro-system level without having to consider its dependence of social interaction, and to the extent it is possible to talk about “control” of this process, that control will be governed by the individuals, not the organization, nor the leader. So as organizations become more dependent of knowledge processes (such as innovation and

intelligence) as oppose to execution of preplanned structures, they will also lose traditional means of power and control. What we need to understand more of, but from an organizational perspective, is how to work with and influence the social processes of micro-systems, which in their fundamental character, are both local and discretionary to the individuals, as well as in many respects private.

Second, only individuals can add the coordination of self-organization. From an intelligence perspective, organizations of today have too much focus and reliance of central control (government through structure). This is of course a result of the “machine paradigm”, that according to Liang, has been dominating our reasoning in relation to organizations for the last 200 years. However, if there is one thing this report can conclude, it is that collective intelligence at micro-system level is a complex phenomenon in which *all* the involved individuals will have influence on the dynamics of the process and, hence, the outcome or results. Both practice and theory tell us that a single individual can hold unproportioned positive or negative influence in a group as well as in organizations, and it is estimated that about 3-5% of the employees do about 20-35% of the value-adding coordination of organizations (Cross, Rebele, & Grant, 2016). Intelligence in organizations will ultimately be a process of self-organization, or discretionary coordination, since intelligent acts can't be planned in a dynamic environment. They can be prepared, so this is not to take away the importance of structures and plans, but the final adjustments and adaptions of actions in relation to reality must be executed *in situ*, in micro-systems. Individual behavior, like OCB or discretionary behavior, has been neglected in favor of studies of leaders and their behavior (Grint, 2005), but as this report shows, establishment of highly intelligent groups seems to

be mainly a local phenomenon and challenge. It is the result of a number of different factors, of which organizations and leaders control only a few. From this perspective, much-needed research would address how organizations can support the development of employees who are locally skillful in contributing to collective intelligence. If 3-5% of the employees seems to know a lot about the secrets in how you do this, and how to act accordingly, we need to understand what it is they do, how they act, what can be learned and copied, how could we train others in this, what are the drawbacks, if any, what is reasonable for organizations to expect and work with, and what is private or “out of bounds”. Ultimately, it will be the cooperative skills of the individuals of the organization that decides the average collaborative ability, and hence the average collective intelligence in the micro-systems. This in turn will decide how much complexity and diversity the organization will be able to manage.

AGREEING ON A MEASURE— THE C-FACTOR?

To support development of organizational tools for local processes, an agreement on measurements would be beneficial. Just as it has been possible to evaluate and foresee a number of individual traits by using g-factor, or IQ, as the common denominator, use of c-factor would serve a purpose in evaluating and comparing results in group research. Such a tool would make it possible to separate the steps of doing research on group intelligence measurements and interventions from research on group performance. If the c-factor establishes similarly strong links with group performance, as g-factor does to individual performance, then analysis of team processes, measurements, interventions, and so forth could be short-circuited to evaluations in terms of c-factor. This would both simplify test procedures and increase comparability between studies. Also,

today there is a heavy dependence on experimental studies using student groups in group research. An established c-factor measurement could be one important step toward making research on practical organizations and teams more widespread than today. Maybe this is the most important of the current knowledge gaps, since groups and micro-systems would ultimately need to have the local control and responsibility of expected collective intelligence. Hence, such measurements should be developed to support groups working on their own relations, processes, and abilities.

PRACTICAL IMPLICATIONS

THE INTELLIGENCE SOCIETY

On a macro level, the volume of knowledge, if we can talk about such a thing, is becoming ever larger. That is, the total amount of knowledge that could be used, transferred, and integrated into some form is constantly increasing. The way we deal with this development (and, you could argue, the reason behind it) is specialization. Specialization and technology increase our capacity to store, retrieve, and communicate certain types of knowledge. So far, however, technology cannot create intelligence. What is specialized and distributed also needs to be coordinated, and the process of bringing detailed knowledge into what we call innovation, creativity, and intelligence still rests with the human brain and collective processes at micro level.

Despite this increase in complexity, the paradigm of how we deal with knowledge and communication still tends to follow that of the industrial society and the ideas of the hierarchical machine-like organizations built of “components” such as departments, units, roles and routines. The fundamental issue of this perspective is that knowledge and information are thought to follow designed and planned patterns. The purpose of the machine is to do, not to think, it is to repeat, not adapt. This view on organizations can be summarized to “get as much done as possible” at “as low a cost (high efficiency) as possible.” It does not matter if we are “producing” public health care or distributing food. This creates a “push” economy, in which we both overuse, and constantly lack, resources in relation to demand. It is always about “how much” instead of “what.” Such patterns create unintelligence. It is because it is not built for intelligence, it is built for “doing” what is already planned.

If the conclusion of this report could be summarized in short, it would be the following. Over time, intelligence will be to deal with reality using as complex interpretation of it as is possible to master. We can assume that reality is infinitely complex. No human brain alone, or collectively, will ever be able to understand, and work with, all aspects of it at the same time. If this is true, it must mean that in a given situation, the one who can master the most advanced interpretation (capturing as much as possible of reality) will have the highest potential for acting intelligently over time. The key word is “master”, because it means that the interpretation must remain useful and workable. This is what is meant by the expression “maximum intelligence must be on the verge of chaos”. Adding additional aspects of reality to the interpretation would mean that it is no longer possible to master. For a single individual this border must be in personal cognitive ability. In collective intelligence however, we must add the process of sharing the interpretation. The border will then become dependent not only of cognitive ability, but also of communicative ability, and that in turn will be dependent of the interacting agents (the individuals) collaborative skill.

To represent reality as closely as possible, we need to cover as many aspects of it as we can master. With a group of people, our possibility to use more perspectives, experience, pattern recognition etc. in the interpretation of reality will increase, in theory. It will increase in reality only if we ensure that it is the differences between the individuals that we try to capture. If the group process instead focus on the overlap in knowledge between the individuals, the value of having multiple brains will diminish. We are not only after individual experience, but also of differences in how brains work. Human brains work differently, emphasizing different things, thinking in different sequences and orders, prioritizing differently and so on. So if we summarize collective intelligence on micro-system level, we want as much difference as

possible in the human brains (different experience, and different ways of thinking) because difference increase our ability to capture more aspects of reality in our shared interpretation. However, the cost of difference is coordination. From this follows, that if we can increase our capacity for coordination, through individual collaborative skills, we will increase our ability to include and use difference.

If we translate this to organizations, we could say that the organizations that have the most skillful collaborators will be the ones who can uphold the most complex shared representations. That in turn, means that they will have the highest potential for intelligence over time. This is true for all advance knowledge processes, such as innovation and creativity. As of today, most human work roles use little of the capacity of the human brain, and even less of the potential in collective intelligence. Most work is simply too simple, and our methods for understanding the utilizations of knowledge and human brains are undeveloped. We do not even really understand what we miss. This development has powerful drivers. Society keeps asking for more creativity, and as with the turning of agricultural to the industrial society, the potential is larger than we can understand. The industrial society was dependent on people learning to read and write. As we taught people this, we also released more of their individual potential. Much more than was needed for working in 19th century factories. The development of society could then take giant leaps, caused by this “unintended” education. In the same way the society of intelligence will, by its need for more advanced and skillful cooperators, will have the potential to bring us to new levels of development.

Firstly, since intelligence prioritize difference, we will connect much more difference. When we realize the challenge of connecting difference, and learn how to develop our skills in this, we will of course start connecting thinking and knowledge in

a way which never have happened before. As learning to read and write gave the consequence of people sharing ideas in an unprecedeted scale, so will connecting different forms of thinking, ideas, patterns etc. We will become connected in a way that we have never been connected before, and this will of course release innovation and creativity in and unprecedeted scale.

Second, the means of this must be connectivity, and connecting knowledge in unforeseeable patterns, in much the same way as the brain works with synapses. We cannot know in advance what knowledge needs to be connected. Therefore, we must make all connections possible. We do not know what patterns within one “area of thinking” may inspire another area and its pattern. Hence, we cannot, and should not, rely on predefined communication; or rather, we can, but it should not be enough. In addition to those, and in addition to all other organizational structures, we need the possibility of connecting all the brains within the organization. This would mean a form of *short-circuiting between management and employees*. The point is that management must have a direct link to all employees, as all employees must have to management, and to each other. It is only when this fundament is in place that an organization can start to realize fully its knowledge potential and intelligence. The technology for this is already in place, and we, as users, are becoming used to the logic of the networking technology, without hierarchical structures, such as Google, Youtube, Facebook, Yammer, Snapchat etc.

Thirdly, not only should individuals be connected, but also the primary points of realizing collective intelligence; the micro-systems. The reason they become key in the intelligence society is that so many of the factors deciding the level of collective intelligence are dependent of the local processes of the micro-systems. The micro-systems therefore contain the basic “volume buttons”, or amplifiers, of collective intelligence in organizations. Below,

we will develop our thinking on the language of collective intelligence, the connectivity of collective intelligence, and, finally, the argument that the development of the intelligence society must be that of addition, not replacement. The “game” will become more complex, not replaced by a new one, and definitely not simplified. As will the players, the tactics, the equipment, the training and so forth.

THE LANGUAGE OF COOPERATION

To start, we argue that the most important factor in releasing the intelligence society will be the problematizing of micro-systems as being intelligent at different levels. Intelligence is then a way of expressing the utilization of available knowledge resources in relation to the purpose of the organization. We can release this potential only by an agreement among the individuals at micro-system level. So this agreement must be built on how knowledge integration works, and translated into a common language. If knowledge of the alphabet was the prerequisite for the industrial and information society, the understanding of human interaction will be the prerequisite for the intelligence society. By modeling, codifying, and defining the metaprocesses of (1) thinking (as in how the brain works), (2) intelligence (definition, modeling in terms of problem-setting, problem-solving, and so forth) and, finally, (3) human interaction (as in reactions, tendencies, signals, categories), we can make collective intelligence workable for those who influence it, the individuals of the micro-systems.

More important than the models as such, at least initially, will be to have *common* models at all, through which we can work and discuss, but above all, recognize that this should be a common workable issue. This is the role of the *language of cooperation*. These first models will be what

Heylighen call the *stigmergy* of collective intelligence, by which the different “thinkers” of the micro-systems can align both their work and their processes.

SHORT-CIRCUITING MANAGEMENT AND EMPLOYEES

It could be argued that the core of intelligence is the ability to bring a “pattern” from one experience into another and to find a relevant use for it. It is the recognition and transferring of patterns from previously unrelated phenomena that can create new perspectives, interpretations etc., which are the foundations of innovation and creativity. Now, by definition such use of patterns cannot be predicted, so we need an architecture allowing for undefined patterns of connectivity. Therefore, in theory, we want it to be possible to establish all possible patterns of communication. In an organization, that would be all employees (and partners to the organization) being able to talk to and connect to any other employee/partner. They would all be potential nodes in catching and transferring patterns from one way of thinking and applying it to another. Based on this report, we argue that the most important nodes of an organization, to create such a platform of unpredicted connectivity, will be the micro-systems. The reason it is the micro-systems rather than the individuals are four:

- 1) The combination of work division, increasing specialization and the sensitivity of knowledge to local social processes means that it is in the micro-system that organizational challenges will be possible to represent with enough perspectives and aspects. That is where most organizational issues (in need of intelligence) will be dealt with.
- 2) It is only in micro-system where levels of intelligence higher than that of the best

individuals can be reached, and since organizations will strive to maximize intelligence, they will have to change from reaching for the current best-person strategy (trying to create “best” organization by hiring the best persons to predefined roles) to a best-micro-system strategy (trying to create the highest performing micro-systems based on both predefined and unexpected knowledge integration).

- 3) Human beings tend to be more motivated to change their behavior in groups, or in this case, in the local micro-system contexts in which they are operational, and organizations in the intelligence society will be changing and adapting constantly.
- 4) Following the arguments of Gantt and Agazarian, the micro-systems are also the most efficient point of intervening in the organization. Using the arguments of the authors, it is the natural node for influence both at organizational and individual level, since the “change” only has to travel through one layer. With today’s capacity for communication, there should no need for additional hierarchical levels from a communication point of view.

Hence, micro-systems will be the relevant organizational object from which to design connectivity.

ADD RATHER THAN REPLACE

Concluding this report, a final point should be that we are developing a more advanced way of playing, not creating a new game. What is meant by this is that changes like those implied here tend to make us think of old structures being replaced by new ones. Here, it is argued that this would be a mistake. Organizations of today have certain structure because they have made sense (at least a lot of them). The old dominating problem was that

of organizing economies of scale. This is still an issue requiring attention. From economies of scale comes efficiency, cost reductions, and so forth. However, it is no longer the dominant problem. In addition to it, we have the issue of intelligence. Economies of scale, left to themselves, risk creating unintelligence, but that does not mean that they are of no interest and it does not make them obsolete. What we need are additional structures, layers of connectivity, objectives, purposes, and so on in organizations, not less. Old truths still hold. Now, this will make things more complicated, but so it is. The world is becoming more complicated every day. Luckily, we have armies of unused intellectuals—today employed for work that uses only a fraction of their potential—ready to deal with this.

REFERENCES

- Adams, S. L., & Anantatmula, V. (2010). Social and behavioral influences on team process. *Project Management Journal*, 41(4), 89-98.
- Ahearne, M., Mackenzie, S. B., Podsakoff, P. M., Mathieu, J. E., Lam, S. K. (2010). The role of consensus in sales team performance. *Journal of Marketing Research*, XLVII, 458–469.
- Albrecht, K. (2003). The power of minds at work: Organizational intelligence in action, New York, NY: Amazon.
- Alvesson, M. 2004. Kunskapsarbete och kunskapsföretag. Malmö: Liber.
- Ancona, D. G. (1990). Outward bound: strategic for team survival in an organization. *Academy of Management Journal*, 33(2), 334-365.
- Anderson, N. R., & West, M. A. (1998). Measuring climate for work group innovation: Development and validation of the team climate inventory. *Journal of Organizational Behavior*, 19(3), 235-258.
- Argyris, C. (1993). Knowledge for action: A guide to overcoming barriers to organizational change. San Francisco, CA: Jossey-Bass Inc., Publishers.
- Argyris, C., & Schön, D. A. (1978). Organizational learning: A theory of action perspective (Vol. 173). Reading, MA: Addison-Wesley.
- Asch, Solomon E. (1952). Social psychology. Englewood Cliffs, NJ: Prentice-Hall, pp. 450-501
- Ashby, W. R. (1947). Principles of the self-organizing dynamic system. *The Journal of General Psychology*, 37(2), 125-128.
- Atlee, T. (2003). Defining “Collective intelligence.” The Co-Intelligence Institute. Available at: <http://co-intelligence.org/CollectiveIntelligence2.html#definitions> [Accessed March 2, 2013].
- Aulinger, A. & Miller, L. (2014). Collective intelligence versus team intelligence. *Collective Intelligence*, Boston: MIT Center for Collective Intelligence.
- Barczak, G., Griffin, A., & Kahn, K. B. (2009). Perspective: Trends and drivers of success in NPD practices—Results of the 2003 PDMA best practices study. *Journal of Product Innovation Management*, 26(1), 3-23.
- Barczak, G., Lassk, Fe., & Mulki, J. (2010). Antecedents of team creativity: An examination of team emotional intelligence, team trust and collaborative culture. *Creativity and Innovation Management*. 19(4), 332-345.
- Barsade, S. G. (2002). The ripple effect: Emotional contagion and its influence on group behavior. *Administrative Science Quarterly*, 47(4), 644-675.
- Bales, R. F. (1950). A set of categories for the analysis of small group interaction, *American Sociological Review*, 15(2), pp. 257-263.
- Bales, R. F. (1953). The equilibrium problem in small groups. In T. Parsons, R. F. Bales, & E. A. Shils (Eds.), Working papers in the theory of action (pp. 111-161), Glencoe, IL: The Free Press.
- Bales, R. F. & Slater, P. E. (1955). Role differentiation. In T. Parsons, & R. F. Bales (Eds.), Family, socialization, and interaction process (pp. 259-306), Glencoe, IL: The Free Press.
- Bales, R. F. & Strodtbeck, F. L. (1951). Phases in group problem solving. *Journal of Abnormal and Social Psychology*, 46, pp. 485-495.
- Bartelt, V. L., & Dennis, A. R. (2014). Nature and nurture: The impact of automaticity and the structuration of communication on virtual team behavior and performance. *MIS Quarterly*, 38(2), 521-538.

- Bateman, T. S., & Organ, D. W. (1983). Job satisfaction and the good soldier: The relationship between affect and employee "citizenship." *Academy of Management Journal*, 26(4), 587-595.
- Bazerman M. H. & Malhotra D. (2006). Economics wins, psychology loses, and society pays. In: D. D. Cremer, J. K. Murnighan, & M. Zeelenberg (Eds.), *Social psychology and economics*. Mahwah, NJ: Lawrence Erlbaum Associates. pp. 263-280.
- Benders, J., Huijgen, F., & Pekruhl, U. (2001). Measuring group work; findings and lessons from a European survey, *New Technology, Work and Employment*, 16(3), 204-217.
- Bion, W.R. (1961). *Experiences in groups*, London: Tavistock/Routledge.
- Bohm, D. (1996). *On dialogue*, ed. L. Nichol. London: Routledge.
- Bommer, W. H., Dierdorff, E. C., & Rubin, R. S. (2007). Does prevalence mitigate relevance? The moderating effect of group-level OCB on employee performance. *Academy of Management Journal*, 50(6), 1481-1494.
- Bonabeau, E. (2009). Decisions 2.0: The Power of Collective Intelligence. *MIT Sloan Management Review*, 50(2), 45-52.
- Boone, C., Brabander, B., & Witteloostuijn, A. (1996). CEO locus of control and small firm performance: An integrative framework and empirical test. *Journal of Management Studies*, 33(5), 667-700.
- Boone, C., De Brabander, B., & Hellemans, J. (2000). Research note: CEO locus of control and small firm performance. *Organization Studies—Berlin—European Group for Organizational Studies*, 21(3), 641-646.
- Boone, C., & Van Witteloostuijn, A. (2005). Team locus-of-control composition, leadership structure, information acquisition, and financial performance: A business simulation study. *Academy of Management Journal*, 48(5), 889-909.
- Boulding, W., Morgan, R., & Staelin, R. (1997). Pulling the plug to stop the new product drain. *Journal of Marketing Research*. 34(1), 164-176.
- Bourdieu, P. (1986). Forms of capital. In J. G. Richardson (Ed.), *Handbook of theory and research for the sociology of education* (pp. 241-60). Westport, CT: Greenwood Press.
- Bourgeois, L. J., McAllister, D. W., & Mitchell, T. R. (1978). The effects of different organizational environments upon decisions about organizational structure. *Academy of Management Journal*, 21(3), 508-514.
- Bourgeois, L. J., III. (1980). Performance and consensus. *Strategic Management Journal*, 1(3), 227-248.
- Brandon, D. P., & Hollingshead, A. B. (2004). Transactional Memory Systems in Organizations: Matching Tasks, Expertise, and People, *Organization Science*, 15(6), 633-644.
- Brauer, M., Gliner, M. D., & Judd, C. M. (1995). The effects of repeated expressions on attitude polarization during group discussions. *Journal of Personality and Social Psychology*, 68(6), 1014-1029.
- Bunderson, J. S. (2003). Recognizing and utilizing expertise in work groups: A status characteristics perspective. *Administrative Science Quarterly*, 48(4), 557-591.
- Bunderson, J.S., & Sutcliffe, K.M. (2003). Management team learning orientation and business unit performance. *Journal of Applied Psychology*, 88(3), 552-560.
- Campion, M.A., Medsker, G.J. and Higgs, A.C. (1993). Relations between work group characteristics and effectiveness: Implications for designing effective work groups. *Personnel Psychology*, 46(4), 823-850.

- Cacioppo, J. T., Petty, R. E., Feinstein, J., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin, 119*(2), 197–253.
- Cannon-Bowers, J. A., Tannenbaum, S. I., Methieu, J. E., & Salas, E. (1993). Factors that influence training effectiveness: A conceptual model and longitudinal analysis (No. NAVTRASYCEN-TR-93-011). NAVAL TRAINING SYSTEMS CENTER ORLANDO FL.
- Cannon-Bowers, J.A., Tannenbaum, S.I., Salas, E., & Volpe, C.E. (1995). Defining competencies and establishing team training requirements. In R. A. Guzzo & E. Salas (Eds.), Team effectiveness and decision-making in organizations, (pp. 333-380). San Francisco, CA: Jossey-Bass.
- Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization Science, 15*(5), 555-568.
- Chen, C. & Mathieu, J.E. (2008). Goal orientation dispositions and performance trajectories: The roles of supplementary and complementary situational inducements. *Organizational Behavior and Human Decision Processes, 106*(1), 21-38.
- Cohen, S. G. & Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of Management, 23*(3), 239-290.
- Cooren, F. (2004). The communicative achievement of collective minding: Analysis of Board Meeting Excerpts. *Management Communication Quarterly, 17* (4).
- Gonzalez, G. (2005). Decision support for real-time, dynamic decision-making tasks. *Organizational Behavior and Human Decision Processes, 96*(2), 142-154.
- Gronin, M. A., Gonzalez, G., & Sterman, J. D. (2009). Why don't well-educated adults understand accumulation? A challenge to researchers, educators, and citizens. *Organizational Behavior and Human Decision Processes, 108*(1), 116-130.
- Cross, R., Rebele, R., & Grant, A. (2016). Collaborative Overload. *Harvard Business Review, 94*(1)(1-2), 74-79.
- DeChurch, L. A. & Mesmer-Magnus, J. R. (2010). Measuring Shared Team Mental Models: A Meta-Analysis. *Group Dynamics: Theory, Research, and Practice. 14*(1), 1-14
- Desvaux, G., Devillard-Hoellinger, S., & Sancier-Sultan, S. (2010). Women matter: Women at the top of corporations: Making it happen. McKinsey Report.
- Donnellon, A., Gray, B., & Bougon, M. G. (1986). Communication, meaning, and organized action. *Administrative Science Quarterly, 43*-55.
- Druskat, V. U. & Wolff, S. B. (2001). Group emotional intelligence and its influence on group effectiveness. In C. Chemiss & D. Goleman (Eds.), The emotionally intelligent workplace (pp. 132-155). San Francisco, CA: Jossey-Bass.
- Durkheim, E. (1893). De la division du travail social. English edition: *The division of labor in society*, New York: Free Press, 1984.
- Edmondson, A. C. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44*(2), 350-383.
- Ehrhart, M. G. & Naumann, S. E. (2004). Organizational citizenship behavior in work groups: A group norms approach. *Journal of Applied Psychology, 89*(6), 960.
- Engel, D., Woolley, A. W., Jing, L. X., Chabris, C. F., & Malone, T. W. (2014). Reading the mind in the eyes or reading between the Lines? Theory of

- Mind Predicts Collective Intelligence Equally Well Online and Face-To-Face. *PLoS ONE*, 9(12).
- Faraj, S. & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science*, 46(12), 1554-1568.
- Financial Times Lexicon. (2013). "Collective intelligence,"
<http://lexicon.ft.com/Term?term=collective-intelligence>, Retrieved March 2, 2013.
- Furusten, S. & Werr, A. (Eds.) (2012) Expertsamhälllets organisering—Okunskapens Triumf? Lund: Studentlitteratur.
- Gantt, S. P. & Agazarian, Y. M. (2004). Systems-centered emotional intelligence: beyond individual systems to organizational systems. *Organizational Analysis*, 12(2), 147-169.
- Gardner, H. K., Gino, F., & Staats, B. R. (2012). Dynamically integrating knowledge in teams: Transforming resources into performance. *Academy of Management Journal*, 55(4), 998-1022.
- Gardner, H., (1993). Frames of mind: The theory of multiple intelligences. New York, NY: Basic Books.
- Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, 31(1), 9–41.
- Gersick, C. J. G. (1989). Marking time: Predictable transitions in task groups. *Academy of Management Journal*, 32(2), 274–309.
- Gibson, C. & Vermeulen, F. (2003). A healthy divide: Subgroups as a stimulus for team learning behavior. *Administrative Science Quarterly*, 48(2), 202-239.
- Gladstein, D. L. (1984). Groups in context: A model of task group effectiveness. *Administrative Science Quarterly*, 29(4), 499–517.
- Glynn, M. A. (1996). Innovative genius: A framework for relating individual and organizational intelligences to innovation. *Academy of Management Review*, 21(4), 1081-1111.
- Gong, Y., Kim, T. Y., Lee, D. R. & Zhu, J. (2013). A multilevel model of team goal orientation, information exchange, and creativity. *Academy of Management Journal*. 56(3), 827-851.
- Gottfredson, L. S. (1997). Mainstream science on intelligence: An editorial with 52 signatories, history and bibliography. *Intelligence*, 24, 13-23.
- Gottfredson, L. S. (1997). Why g matters: The complexity of everyday life. *Intelligence*, 24(1), 79-132.
- Govindarajan, V. (1988). A contingency approach to strategy implementation at the business-unit level: Integrating administrative mechanisms with strategy. *Academy of Management Journal*, 31(4), 828–853.
- Govindarajan, V. (1989). Implementing competitive strategies at the business unit level: Implications of matching managers to strategies. *Strategic Management Journal*, 10(3), 251–270.
- Goyal, A. & Akhilesh, K. B. (2007). Interplay among innovativeness, cognitive intelligence, emotional intelligence and social capital of work teams. *Team Performance Management*, 13(7/8), 206-226.
- Gully, S. M., & Phillips, J. M. (2005). A multilevel application of learning and performance orientations to individual, group, and organizational outcomes. In J. Martocchio (Ed.), *Research in personnel and human resources management*, Vol. 24, (pp. 1–51). Greenwich, CT: JAI.
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), 109-122.
- Graves, R. (1842). *Clinical lectures*. Philadelphia: Barrington & Haswell.

- Greenberg, J., & Baron, R. A. (1997). *Behavior in organizations*. Upper Saddle River, NJ: Prentice-Hall.
- Grofman, B. (1978). Judgmental competence of individuals and groups in a dichotomous choice situation: Is a majority of heads better than one? *Journal of Mathematical Sociology*, 6(1), 47-60.
- Hackman, J. R. (1976). Group influences on individuals. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology*. Chicago, IL: Rand-McNally.
- Hackman, J. R. (1977). The design of self-managing work groups. In B. T. King, S. S. Streufort, and F. E. Fiedler (Eds.), *Managerial control and organizational democracy*. Washington, DC: Winston and Sons.
- Hackman, J. R. (1987). The design of work teams. In J. W. Lorsch (Ed.), *The handbook of organizational behavior* (pp. 315-342). Englewood Cliffs, NJ: Prentice-Hall.
- Hackman, J. R. & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz, (Ed.), *Advances in experimental social psychology*, Vol 8, New York, NY: Academic Press.
- Halfhill, T., Sundstrom, E., Jessica, L., Calderone, W., & Nielsen, T. M. (2005). Group personality composition and group effectiveness: An integrative review of empirical research. *Small Group Research*, 36(1), 83-105.
- Hargadon, A. B. (1998). Firms as knowledge brokers: Lessons in pursuing continuous innovation. *California Management Review*, 40(3), 209-227.
- Hargadon, A. B., & Bechky, B. A. (2006). When collections of creatives become creative collectives: A field study of problem solving at work. *Organization Science*, 17(4), 484-500.
- Hare, A. P. (1973). Theories of group development and categories for interaction analysis. *Small Group Behavior*, 4(3), 259-304.
- Hare, A. P. (1976). *Handbook of small group research* (2nd ed.). Glencoe, IL: The Free Press.
- He, J., Butler, B. S., & King, W. R. (2007). Team cognition: Development and evolution in software project teams. *Journal of Management Information Systems*, 24(2), 261-292.
- Heylighen, F. (1999). Collective Intelligence and its Implementation on the Web: Algorithms to develop a collective mental map. *Computational and Mathematical Organization Theory*, 5(3), 253-280.
- Heylighen, F. (2013). Self-organization in communicating groups: The emergence of coordination, shared references and collective intelligence. In Complexity Perspectives on Language, Communication and Society (pp. 117-149). Springer Berlin Heidelberg.
- Hess, J. D., & Bacigalupo, A. C. (2011). Enhancing decisions and decision-making processes through the application of emotional intelligence skills. *Management Decision*, 49(5), 710-721.
- Hiltz, S. R., Johnson, K., & Turoff, M. (1991). Group decision support: The effects of designated human leaders and statistical feedback in computerized conferences. *Journal of Management Information Systems*, 8(2), 81-108.
- Hiltz, S. R., & Turoff, M. (1978). *The network nation: Human communication via computer*. Reading, MA: Addison-Wesley.
- Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin*, 121(1), 43.

- Hitsch, G. I. (2006). An empirical model of optimal dynamic product launch and exit under demand uncertainty. *Marketing Science*, 25(1), 25-50.
- Hoffman, L. R. & Maier, N. R. (1961). Quality and acceptance of problem solutions by members of homogeneous and heterogeneous groups. *Journal of Abnormal and Social Psychology*, 62(2), 401-7.
- Hoffman, R. R., Shadbolt, N. R., Burton, A. M., & Klein, G. (1995). Eliciting knowledge from experts: A methodological analysis. *Organizational Behavior and Human Decision Processes*, 62(2), 129-158.
- Homan, A. C., Hollenbeck, J. R., Humphrey, S. E., Van Knippenberg, D., Ilgen, D. R., & Van Kleef, G. A. (2008). Facing differences with an open mind: Openness to experience, salience of intragroup differences, and performance of diverse work groups. *Academy of Management Journal*, 51(6), 1204-1222.
- Huang, J. C. (2012). The relationship between conflict and team performance in Taiwan: The moderating effect of goal orientation. *The International Journal of Human Resource Management*, 23(10), 2126-2143.
- Huber, G. P., Lewis, K. (2010). Cross-understanding: Implications for group cognition and performance. *Academy of Management Review*, 35(1), 6-26.
- Hurley, E. A., & Allen, B. A. (2007). Asking the how questions: Quantifying group processes behaviors. *The Journal of General Psychology*, 134(1), 5-21.
- Hutchins, E. (1990). The technology of team navigation. Intellectual teamwork: Social and technological foundations of cooperative work, 1, 191-220.
- Huy, Q. N. (1999). Emotional capability, emotional intelligence, and radical change. *Academy of Management Review*, 24(2), 325-345.
- Isaacs, W. (1999). Dialogue and the art of thinking together. New York: Doubleday Currency.
- Janis, I. L. (1982). Groupthink: Psychological studies of policy decisions and fiascoes. Boston, MA: Houghton Mifflin.
- Johnson-Laird, P. N. (1983). Mental models: Towards a cognitive science of language, inference, and consciousness (No. 6). Harvard University Press.
- Kahai, S. S., Sosik, J. J., & Avolio, B. J. (2004). Effects of participative and directive leadership in electronic groups. *Group & Organization Management*, 29(1), 67-105.
- Katzenbach, J. R., & Smith, D. K. (1993). *The wisdom of teams: Creating the high performance organization*. Cambridge, MA: Harvard Business School Press.
- Kearney, E., Gerbert, D., & Voelpel, S. C. (2009). When and how diversity benefits teams: The importance of team members' need for cognition. *Academy of Management Journal*, 52(3), 581-598.
- Kelly, J. & Barsade, S. (2001). Moods and emotions in small groups and work teams. *Organizational Behavior and Human Decision Processes*, 86(1), 99-130.
- Kidd, D. C. & Castano, E. (2013). Reading literary fiction improves theory of mind. *Science*, 342(6156), 377-380.
- Kilduff, M., Angelmar, R., & Mehra, A. (2000). Top management-team diversity and firm performance: Examining the role of cognitions. *Organization Science*, 11(1), 21-34.
- Kim, P. H. (1997). When what you know van hurt you: A study of experiential effects on group discussion and performance. *Organizational Behavior and Human Decision Processes*, 69(2), 165-177.

- Kim, P. H. (2003). When private beliefs shape collective reality: The effects of beliefs about coworkers on group discussion and performance. *Management Science*, 49(6), 801-815.
- Klimoski, R., & Mohammed, S. (1994). Team mental model: Construct or metaphor?. *Journal of Management*, 20(2), 403-437.
- Klein, C., DiazGranados, D., Salas, E., Huy, L. C., Burke, S. C., Lyons, R. & Goodwin, G. F. (2009) Does Teambuilding work? *Small Group Research*. 40 (2), 181-222
- Kornrumpf, A. & Baumöl, U. (2013). From collective intelligence to collective intelligence systems: Definitions and a semi-structured model. *International Journal of Cooperative Information Systems*, 22(3).
- Kornrumpf, A. & Baumöl, U. (2013). From collective intelligence to collective intelligence systems: Definitions and a semi-structured model. *International Journal of Cooperative Information Systems*, 22(3).
- Kozlowski, S. W. J., & Bell, B. S. (2006). Disentangling achievement orientation and goal setting: effects on self-regulatory processes. *Journal of Applied Psychology*, 91(4), 900–916.
- Kray, L. J. & Galinsky, A. D. (2003). The debiasing effect of counterfactual mind-sets: Increasing the search for disconfirmatory information in group decisions. *Organizational Behavior and Human Decision Processes*, 91(1), 69–81.
- Kuipers, B. S., & Stoker, J. I. (2009). Development and performance of self-managing work teams: A theoretical and empirical examination. *The International Journal of Human Resource Management*, 20(2), 399-419.
- Langfred, C. W. (2004). Too much of a good thing? Negative effects of high trust and individual autonomy in self-managing teams. *Academy of Management Journal*, 47(3), 385-399.
- Le Bon, G. (1895). Psychologie des Foules. 1963 Edition by Presses Universitaires de France, Paris.
- Lee, H., Park, J., & Lee, J. (2013). Role of leadership competencies and team social capital. *Journal of Computer Information Systems*. 53(4), 1-11.
- Legg, S. & Hutter, M. (2007). A collection of definitions of intelligence. *Frontiers in Artificial Intelligence and applications*, 157, 17.
- Levine, J. M. & Moreland, R. L. (1990). Progress in small group research. *Annual Review of Psychology*, 41(1), 585-634.
- Levy, P. (1994). L'intelligence collective: Pour une anthropologie du cyberspace. Paris, France: Editions La Decouverte. (English edition: P. Levy (1997) Collective Intelligence: Mankind's Emerging World in Cyberspace. New York: Plenum Press.)
- Lewis, K., Lange, D., Gillis, L. 2005. Transactive Memory systems, learning, and learning transfer. *Organization Science*, 16(6), 581-598.
- Liang, T. Y. (2007). The new intelligence leadership strategy for iCAS. *Human Systems Management*, 26(2), 111-122.
- Libby, R., Trotman, K. T., & Zimmer, I. (1987). Member variation, recognition of expertise, and group performance. *Journal of Applied Psychology*, 72(1), 81.
- Littlepage, G. E., Schmidt, G. W., Whisler, E. W., & Frost, A. G. (1995). An input-process-output analysis of influence and performance in problem-solving groups. *Journal of Personality and Social Psychology*, 69(5), 877.
- Locke, E. A. & Latham, G. P. (1990). *A theory of goal setting & task performance*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
- Locke, E. A., Shaw, K. N., Saari, L. M., & Latham, G. P. (1981). Goal setting and task performance: 1969–1980. *Psychological Bulletin*, 90(1), 125.

- Lorge, I. & Solomon, H. (1955). Two models of group behavior in the solution of eureka-type problems. *Psychometrika*, 20(2), 139-148.
- Lorinkova, N. M., Pearsall, M. J., & Sims, H. P. (2013). Examining the differential longitudinal performance of directive versus empowering leadership in teams. *Academy of Management Journal*, 56(2), 573-596.
- Losada, M., Heaphy, E. (2004). The role of positivity and connectivity in the performance of business teams. *The American Behavioral Scientist*, 47(6), 740-765.
- Lyubovnikova, J., West, M. A., Dawson, J. F. & Carter, M. R. (2015). 24-Karat or fool's gold? Consequences of real team and co-acting group membership in healthcare organizations. *European Journal of Work and Organizational Psychology*, 24 (6), 929-950
- Malone, T.W., Bernstein, M.S., (Eds.) Collective Intelligence Handbook [tentative title], MIT Press, in press. (https://docs.google.com/document/d/1CRVN8u xa_g8i3oLRFvXhsItWNZ_ZMwoIpl5IosG9VU/edit?pli=1)
- Mathieu, J. E., Heffner, T. S., Goodwin, D. F., Salas, E., Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology*, 85(2), 273-283.
- March, J. G. (2006). Rationality, foolishness, and adaptive intelligence. *Strategic Management Journal*, 27(3), 201-214.
- McIntyre, R. & Salas, E. (1995). Measuring and managing for team performance: Emerging principles from complex environments. In R. Guzzo & E. Salas (Eds.), *Team effectiveness and decision-making in organizations* 9-45. San Francisco: Jossey-Bass.
- Merriam-Webster online dictionary (200911). <http://www.merriam-webster.com/dictionary/group>.
- Mayer, J.D. and Caruso, D. (2002), The effective leader: Understanding and applying emotional intelligence. *Ivey Business Journal*, 67(2), 1-5.
- Mayer, J. D. and Salovey, P. (1997), What is emotional intelligence? In P. Salovey and D. Sluyter (Eds.), *Emotional development and emotional intelligence: educational implications* (pp. 3-31). New York, NY: Basic Books.
- Miller, D. & Toulouse, J. M. (1986). Chief executive personality and corporate strategy and structure in small firms. *Management Science*, 32(11), 1389-1409.
- Minas, R. K., Potter, R. F., Dennis, A. R., Bartelt, V., & Bae, S. (2014). Putting on the thinking cap: Using neuroIS to understand information processing biases in virtual teams. *Journal of Management Information Systems*, 30(4), 49-82.
- Mohammed, S., Dumville, B. C. (2001). Team mental models in a team knowledge framework: expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior*, 22(2), pp. 89-106.
- Mohr, J. J., Batalden, P., & Barach, P. (2004). Integrating patient safety into the clinical micro-system. *Quality and Safety in Health Care*. 13(Suppl 2), ii34-ii38.
- Mohrman, S. A. & Cohen, S. G. (1995). When people get out of the box: New relationships, new systems. In A. Howard, (Ed.), *The changing nature of work* (pp. 365-410). San Francisco, CA: Jossey-Bass.
- Moore, A. & Mamiseishvili, K. (2012). Examining the relationship between emotional intelligence and group cohesion. *Journal of Education for Business*, 87(5), 296-302.

- Mulec, K. & Roth, J. (2005). Action, Reflection, and—Coaching in order to enhance the performance of drug development project management teams. *R&D Management*, 35(5), 483-491.
- Nelson, B. (2014). The data on diversity. *Communications of the ACM*, 57(11), 86-95.
- Okhuysen, G. A. (2001). Structuring change: Familiarity and formal interventions in problem-solving groups. *Academy of Management Journal*, 44(4), 794-808.
- O'Leary-Kelly, A. M., Martocchio, J. J. & Frick, D. D., (1994). A review of the influence of group goals on group performance. *Academy of Management Journal*, 37(5), 1285-1301.
- Orlikowski, W. J., & Yates, J. (1994). Genre repertoire: The structuring of communicative practices in organizations. *Administrative Science Quarterly*, 39(4), 541-574.
- Organ, D. W. (1988) *Organizational citizenship behavior*. Lexington, MA: Lexington Books.
- Othman, A. K., Abdullah, H. S., & Ahmad, J. (2009). The influence of work motivation on emotional intelligence and team effectiveness relationship. *Vision: The Journal of Business Perspective*, 13(4), 1-14.
- Pan, G. & Pan, S. L. (2006). Examining the coalition dynamics affecting IS project abandonment decision-making. *Decision Support Systems*. 42(2), 639-655.
- Pearce, C. L. & Conger, J. A. (Eds.). (2003). *Shared leadership. Reframing the hows and whys of leadership*. Thousand Oaks, CA: SAGE Publications.
- Petty, R. E., Brinol, P., Loersch, C., & McCaslin, M. J. (2009). The need for cognition. In M. R. Leary & R. H. Hoyle (Eds.), *Handbook of individual differences in social behavior* (pp. 318–329). New York, NY: Guilford Press.
- Podsakoff, P. M., Ahearne, M., & MacKenzie, S. B. (1997). Organizational citizenship behavior and the quantity and quality of work group performance. *Journal of Applied Psychology*, 82, 262–270.
- Podsakoff, P. M., MacKenzie, S. B., Paine, J. B., & Bachrach, D. G. (2000). Organizational citizenship behaviors: A critical review of the theoretical and empirical literature and suggestions for future research. *Journal of Management*, 26(3), 513-563.
- Pór, G. (2004). http://www.community-intelligence.com/blogs/public/2004/08/defining_collective_intelligence.html
- Prati, L. M., Douglas, C., Ferris, G. R., Ammeter, A. P., & Buckley, M. R. (2003). Emotional intelligence, leadership effectiveness, and team outcomes. *The International Journal of Organizational Analysis*, 11(1), 21-40.
- Price, K. H., (1987). Decision responsibility, task responsibility, identifiability, and social loafing. *Organizational Behavior and Human Decision Processes*, 40(3), 330-345.
- Pumroy, J. (1846). The Annual Address Delivered Before the Diagnothian and Goethean Literary Societies of Marshall College, Mercersburg, PA: On the connection between government, and science and literature, Harrisburg, PA: McKinley and Lescure.
- Putnam, R. (1995). Bowling alone: America's declining social capital. *Journal of Democracy*, 6(1), 65-78.
- Randel, A. E., & Jaussi, K. S. (2003). Functional background identity, diversity, and individual performance in cross-functional teams. *Academy of Management Journal*, 46(6), 763-774.
- Ramanujam, R. & Goodman, P. S. (2003). Latent errors and adverse organizational consequences: a conceptualization. *Journal of Organizational Behavior*, 24(7), 815-836.

- Raye, J. (2014). Fractal organisation theory. *Journal of Organisational Transformation & Social Change*, 11(1), 50-68.
- Reagans, R., Argote, L., & Brooks, D. (2005). Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. *Management Science*, 51(6), 869-881.
- Rentsch, J. R. & Hall, R. J. (1994). Members of great teams think alike: A model of team effectiveness and schema similarity among team members. *Advances in Interdisciplinary Studies of Work Teams*, 1, 223-261.
- Rico, R., Sanchez-Manzanares, M., Gil, F., & Gibson, C. (2008). Team implicit coordination processes: A team knowledge-based approach. *Academy of Management Review*, 33(1), 163-194.
- Ringer, T. M. (2007). Leadership for collective thinking in the workplace. *Team Performance Management: An International Journal*, 13(3/4), 130-144.
- Rouse, W. B. & Morris, N. M. (1986). On looking into the black box: Prospects and limits in the search for mental models. *Psychological Bulletin*, 100(3), 349.
- Runsten, P. (2011). Kollektiv förmåga: En avhandling om grupper och kunskapsintegration. Diss. Stockholm School of Economics.
- Runsten, P. & Werr, A. (2016) Kunskapsintegration—Om kollektiv intelligens i organisationer. Lund: Studentlitteratur.
- Ryle, G. (1949). *The concept of mind*. Chicago, IL: University of Chicago Press.
- Salas, E., DiazGranados, D., Klein, C., Burke, S. C., Stagl, K. C., Goodwin, G. F. & Halpin, S. M. (2008). Does Team Training Improve Team Performance? A Meta-Analysis. *Human factors*, 50 (6), 903–933
- Salovey, P. & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, 9(3), 185-211.
- Sandelands, L. E. & Stablein, R. E. (1987). The concept of organization mind. *Research in the Sociology of Organizations*, 5, 135-161.
- Schön, D. (1983). The reflective practitioner: How professionals think in action. New York: Basic books.
- Senge, P. M., (1990). The fifth discipline: The art and practice of the learning organization. New York, NY: Doubleday.
- Sengupta, K. & Abdel-Hamid, T. K. (1993). Alternative conceptions of feedback in dynamic decision environments: An experimental investigation. *Management Science*, 39(4), 411-428.
- Shen, X. L., Lee, M. K., & Cheung, C. M. (2012). Harnessing collective intelligence of Web 2.0: Group adoption and use of Internet-based collaboration technologies. *Knowledge Management Research & Practice*, 10(4), 301-311.
- Sherman, J. D. & Keller, R. T. (2011). Suboptimal assessment of interunit task interdependence: Modes of integration and information processing for coordination performance. *Organization Science*, 22(1), 245-261.
- Shields, C. W. (1889). *Philosophia ultima*. (Vol. 2). New York, NY: Charles Scribner's Sons.
- Simons, T. L. & Peterson, R. S. (2000). Task conflict and relationship conflict in top management teams: The pivotal role of intragroup trust. *Journal of Applied Psychology*, 85(1), 102–111.
- Smith, A. (1795). *The Theory of Moral Sentiments*. Printed for A. Millar, in the Strand; and A. Kincaid and J. Bell, in Edinburgh.
- Smith, C. A., Organ, D. W., & Near, J. P. (1983). Organizational citizenship behavior: Its nature and

- antecedents. *Journal of Applied Psychology*, 68(4), 653.
- Smith, J. B., (1994). Collective Intelligence in computer-based collaboration. Hillsdale, NJ: Lawrence Erlbaum.
- Sorkin, R. D., Hays, C. J., & West, R. (2001). Signal-detection analysis of group decision-making. *Psychological Review*, 108(1), 183.
- Staw, B. M. (1976). Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. *Organizational Behavior and Human Performance*. 16(1), 27-44.
- Steiner, I. D. (1966). Models for inferring relationships between group size and potential group productivity. *Behavioural Science*, 11(4), 273-83.
- Steiner, I. D. (1972). *Group process and productivity*. New York, NY: Academic Press.
- Steiner, I. D. (1974). Whatever happened to the group in social psychology? *Journal of Experimental Social Psychology*, 10(1), 94-108.
- Steiner, I. D. (1966). Models for inferring relationships between group size and potential group productivity. *Behavioural Science*, 11(4), 273-83.
- Sterman, J. D. (1989). Modeling managerial behavior: misperceptions of feedback in a dynamic decision-making experiment. *Management Science*, 35(3), 321-339.
- Stevens, M. J. & Campion, M. A. (1994). The knowledge, skill, and ability requirements for teamwork: implications for human resource management. *Journal of Management*, 20(2), 503-530.
- Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of Management Journal*, 43(2), 135-148.
- Stubbs, E. C. (2005). Emotional intelligence competencies in the team and team leader: A multi-level examination of the impact of emotional intelligence on group performance (Doctoral dissertation, Case Western Reserve University).
- Surowiecki, J. (2005). *The Wisdom of Crowds*. New York, NY: Anchor.
- Swezey, R.W. & Salas, E. (1992). Guidelines for use in team-training development. In R.W. Swezey & E. Salas, (Eds.), *Teams: Their training and performance* (pp. 219-245). Norwood, NJ: Ablex.
- Szuba, T. (2001). A formal definition of the phenomenon of collective intelligence and its IQ measure, *Future Generation Computer Systems*, 17(4), 489-500.
- Tannenbaum, R. and Schmidt, W. F. (1958). How to choose a leadership pattern. *Harvard Business Review*, May-June, 162-80.
- Thomas, D. M., & Bostrom, R. P. (2010b). Vital signs for virtual teams: An empirically developed trigger model for technology adaptation interventions. *MIS Quarterly*, 34(1), 115-142.
- Tsoukas, H. (1996). The firm as a distributed knowledge system: A constructionist approach. *Strategic Management Journal*, 17(S2), 11-25.
- Tubbs, M. E. (1986). Goal setting: A meta-analytic examination of the empirical evidence. *Journal of Applied Psychology*, 71, 474-483.
- Tuckman, B. W. (1965). Development sequences in small groups, *Psychological Bulletin*, 63(6), 384-399.
- Van Der Vegt, G. S. & Bunderson, J. S. (2005). Learning and performance in multidisciplinary teams: The importance of collective team

- identification. *Academy of Management Journal*, 48(3), 532-547.
- Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science*, 32(5), 590-607.
- Van Oorschot, K. E., Akkermans, H., Sengupta, K., & Van Wassenhove, L. N. (2013). Anatomy of a decision trap in complex new product development projects. *Academy of Management Journal*. 56(1), 258-307.
- Vroom, V. H., & Yetton, P. W. (1973). *Leadership and decision-making* (Vol. 110). Pittsburgh, PA: University of Pittsburgh Press.
- Vroom, V. H., & Jago, A. G. (1988). *The new leadership: Managing participation in organizations*. Englewood Cliffs, NJ: Prentice Hall.
- Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly*, 40, 145-180.
- Ward, L. F. (1906). *Applied sociology*, Boston, MA: Ginn and Co.
- Waterson, P. E., Clegg, C. W., Bolden, R., Pepper, K., Warr, P.B., and Wall, T.D. (1999), The use and effectiveness of modern manufacturing practices: a survey of UK industry. *International Journal of Production Research*, 37(10), 2271–2292.
- Wechsler, D. (1971). Concept of collective intelligence. *American Psychologist*, 26(10), 904-907.
- Wechsler, D. (1958). *The measurement and appraisal of adult intelligence* (4th ed.). Baltimore, MD: Williams & Wilkins Co.
- Wegner, D. M. (1987). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185-208). New York, NY: Springer.
- Weick, K. E. 1979. *The social psychology of organizing*. New York, NY: Random House.
- Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly*, 28(3), 357-381.
- Weick, K. E., (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.
- Weitz, B. A., Sujan, H., & Sujan, M. (1986). Knowledge, motivation, and adaptive behavior: A framework for improving selling effectiveness. *The Journal of Marketing*, 50(4), 174-191.
- Werr, A. & Runsten, P. (2013). Understanding the role of representation in interorganizational knowledge integration—A case study of an IT outsourcing project. *The Learning Organization*, 20(2) 118-133.
- Wheelan, S. (2005). *Creating effective teams: A guide for members and leaders* (3rd ed.). New York, NY: Sage.
- Wikipedia. (2013). Collective intelligence, http://en.wikipedia.org/wiki/Collective_intelligence, Retrieved March 2, 2013.
- Williams, K. D. & Karau, S. J. (1991). Social loafing and social compensation: The effects of expectations of coworker performance. *Journal of Personality and Social Psychology*, 61(4), 570–581.
- Williams, K. Y. & O'Reilly, C. A. (1998). Demography and diversity in organizations. In R. I. Sutton & B. M. Staw (Eds.), *Research in organizational behavior* (pp. 77–140). Greenwich, CT: JAI Press.
- Williams, W. M. & Sternberg, R. J. (1988). Group intelligence: Why some groups are better than others, *Intelligence*, 12(4), 351-77.
- Witte, E. H., & Engelhardt, G. (2004). Towards a theoretically based group facilitation technique for project teams. Hamburger Forschungsberichte aus dem Arbeitsberichte, sozialpsychologie, HAFOS #52

- Wittenbaum, G. M. (1998). Information sampling in decision-making groups: The impact of members' task-relevant status. *Small Group Research*, 29(1) 57-84.
- Wittenbaum, G. M., Hubbell, A., & Zuckerman, P. C.. (1999). Mutual enhancement: Toward an understanding of the collective preference for shared information. *Journal of Personality and Social Psychology*, 77(5), 967-978.
- Wittenbaum, G. M., Stasser, G., & Merry, C. J.. (1996). Tacit coordination in anticipation of small group task completion. *Journal of Experimental Social Psychology*, 32(2) 129–152.
- Wittenbaum, G. M., Vaughan, S. I., & Stasser, G. (1998). Coordination in task performing groups. In R. S. Tindale, L. Heath, J. Edwards, E. J. Posavac, F. B. Bryant, Y. Suarez-Balcazar, E. Henderson-King, J. Myers, (Eds.), *Theory and research on small groups* (pp. 177–204). New York, NY: Plenum Press.
- Wolff, S. B., Pescosolido, A. T., & Druskat, V. U. (2002). Emotional intelligence as the basis of leadership emergence in self-managing teams. *The Leadership Quarterly*, 13(5), 505-522.
- Wong, S. S. (2004). Distal and local group Learning: Performance trade-offs and tensions. *Organization Science*, 15(6), 645-656.
- Woolley, A. W. (2009). Means vs. ends: Implications of process and outcome focus for team adaptation and performance. *Organization Science*, 20(3), 500-515.
- Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups, *Organization Science*, 330(6004), 686-688.
- Yates, J. & Orlikowski, W. J. (1992). Genres of organizational communication: A structuration approach to studying communication and media. *Academy of Management Review*, 17(2), 299-326.
- Yates, J., Orlikowski, W. J., & Okamura, K. (1999). Explicit and implicit structuring of genres in electronic communication: reinforcement and change of social interaction. *Organization Science*, 10(1), 83-103.
- Yoon, S. W., Song, J. H., Lim, D. H. & Joo, B. K. (2010). Structural determinants of team performance: The mutual influences of learning culture, creativity, and knowledge. *Human Resource Development International*. 13(3), pp. 249-264.
- Yukl, G. A. (1998). Leadership in organizations. Englewood Cliffs, NJ: Prentice Hall.
- Yun, S., Faraj, S., & Sims, H. P. (2005). Contingent leadership and effectiveness of trauma resuscitation teams. *Journal of Applied Psychology*, 90(6),1288-1296.
- Zander, A. (1980). The origins and consequences of group goals. Retrospections on social psychology, 205, 235.
- Zhang, X., & Bartol, K. M. (2010). Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement. *Academy of Management Journal*, 53(1), 107-128.

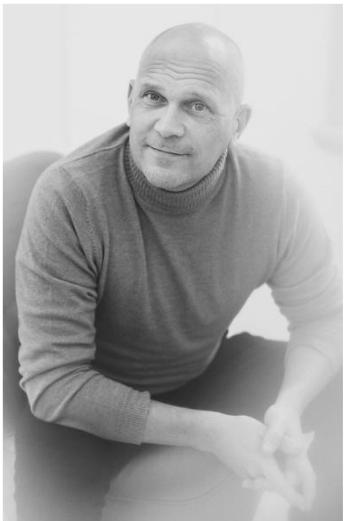
APPENDICES

	Learning	Knowledge system
Group pattern	<p>Goyal & Akhilesh: general ability: cognitive intelligence, emotional intelligence, and social capital</p> <p>Mayer and Salovey: emotional intelligence: (1) Emotional perception (EP) (2) Facilitating cognition (FC) (3) Emotional understanding (EU) (4) Emotional management (EM)</p> <p>Gantt and Agazarian: a system-centered model of emotional intelligence</p> <p>Druskat and Wolff: emotional intelligence in groups, group norms</p> <p>Lee, Park, & Lee: group social climate decides whether the competence of the leader will influence group performance</p> <p>Edmondson: team psychological safety</p> <p>Barczak, Lassk, and Mulki: team trust</p> <p>Yoon, Song, Lim, and Joo: culture and collaboration practice at organizational level influence learning and creativity at team level</p> <p>Kearney, Gebert, and Voelpel: need for cognition as a moderator of diversity influence</p> <p>Gong, Kim, Lee, and Zhu: team goal orientation</p> <p>Oorschot et al.: information filters: the mixed signals filter, the waterbed filter, and the understaffing filter</p> <p>Putnam: social capital: (1) bonding social capital (2) bridging social capital</p> <p>Wong: local learning vs. distal learning</p> <p>Okhuysen: self-generated interruptions</p> <p>Gibson & Vermeulen: subgroup strength</p> <p>Huang: team conflicts: task vs. relationship conflicts</p> <p>Bartlet and Denis: genre rule</p> <p>Nelson: diversity</p> <p>Kearney, Gebert, and Voelpel: reward structure</p> <p>Woolley et al.: number of women on the team</p>	<p>Heylighen: self-organization: Collective intelligence as result of such processes</p> <p>Mathieu et al.: shared mental models</p> <p>Heylighen: "collective mental maps:" mechanism of "stigmergy"</p> <p>Ahearne et al.: lack of consensus: find that the cognitive factor of consensus affects the influence of behavior on performance (LEBs or leadership empowerment behavior)</p> <p>Huber & Lewis: cross-understanding: a group-level compositional construct having as its components each group member's understanding of each other member's mental model</p> <p>Van der Vegt & Bunderson: Group identity</p> <p>Adams and Anantatmula: self-identity and an explanation of how an individual's social and behavioral tendencies can influence the formation of social identity, group emotion, group mood, and emotional intelligence</p> <p>O'Leary-Kelly et al.: group goalsetting</p> <p>Stewart & Berrick: interdependency</p> <p>Raye: hierarchies: causing problems for the natural flow of information</p> <p>Ancona: external relations</p>
Individual factors	<p>Bonabeau: different forms of bias of the human brain: biases in generation of solutions, biases in evaluation of solutions</p> <p>Kim: beliefs about coworkers</p> <p>Minas et al.: NeuroIS information processing biases</p>	<p>Weick & Roberts: heedful interrelating in high reliability organizations</p> <p>Cooren: heedful interrelating explaining coordination in ordinary organizations</p> <p>Kilduff et al.: early interpretative ambiguity and late heedful interrelating</p>

	<p>Engel et al.: social perceptiveness in virtual groups</p> <p>Reagans et al.: individual experience: (a) the proficiency of individual workers, (b) the ability of firm members to leverage knowledge accumulated by others, (c) the capacity for coordinated activity</p> <p>Tannenbaum & Cerasoli: after-action-reviews</p>	<p>Faraj & Sproull: expertise coordination: bringing expertise to bear</p> <p>Moore and Mamiseishvili: individual emotional intelligence</p> <p>Stubbs: team leader emotional intelligence, team level emotional intelligence, and team performance</p> <p>Othman et al.: work motivation on the relationship between Emotional Intelligence (EI) factors (Self Emotional Appraisal, Others' Emotion Appraisal, Regulation of Emotion, and Use of Emotion) and team role effectiveness</p> <p>Woolley et al.: average social sensitivity of group members, the equality in distribution of conversational turn-taking, and the proportion of females in the group, in relation to c-factor</p> <p>Shen, Lee, Cheung: we-intention: one's perception of the group acting as a unit</p> <p>Randel & Jaussi: group identity</p> <p>Bunderson: team members' status cues as indicators of their task expertise</p> <p>Hurley & Allen: group behaviors that could be connected to process loss and process gains</p> <p>Lorinkova et al.: empowering versus directive leadership</p> <p>Boone et al.: internal locus of control (LOC)</p> <p>Bommer and Dierdorff: group-level OCB, individual level OCB, and work performance (Organizational Citizenship Behavior)</p>
--	---	---

Table A:1 Overview of references in relation to analytical model

ABOUT THE AUTHOR



Philip Runsten is a researcher at the Stockholm School of Economics Institute for Research (SIR), where he also earned his Ph.D. with a dissertation on knowledge integration in knowledge intensive teams. His current research focus on collective intelligence in teams and micro-systems. Philip has also been involved in founding and managing several professional service firms in the IT and management sector, such as the consulting firm Influence, where he currently acts as consultant and advisor in organizational development."

The report Team Intelligence; The foundations of intelligent Organizations – A Literature Review, compiles the latest literature in the area of Collective Intelligence. Financed by Vinnova, the report describes different factors contributing to the creation of Collective Intelligence. Furthermore, the report discusses how Collective Intelligence can be developed in groups. The purpose of the report is to create a foundation for future development of tools and methods within the area. The report is available for free download at www.influence.se.

