

# Collaborate as a flock in the organization: how selection and synthesis influence knowledge convergence within a complex adaptive system

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## Abstract

**Purpose** – This study aims to investigate how two collaborative methods – selection and synthesis – influence knowledge convergence when people articulate a new strategic direction driving transformation within the organization.

**Design/methodology/approach** – The study is based on a longitudinal field experiment developed in four organizations involving 82 employees over a three-month process. Inspired by dynamics governing flocks as complex adaptive systems, selection and synthesis have been separately used in two sets of companies. Primary and secondary data have been largely collected and analyzed throughout the whole process.

**Findings** – This study describes how the two alternative methods differently influenced two kinds of knowledge convergence. While selection triggers a general and static knowledge convergence and the propagation of individual knowledge over time, synthesis fosters a local and dynamic knowledge convergence where individuals tend to propagate knowledge generated collectively.

**Research limitations/implications** – This research offers insights into understanding the influence of alternative collaborative methods on the creation and propagation of knowledge when people are converging toward a new strategic direction. From a theoretical perspective, it contributes to complex adaptive system theory, highlighting the role of knowledge convergence and emergence through collaboration.

**Practical implications** – This research offers insights to managers who deal with the complexity of the engagement of different stakeholders during collaborative processes, offering some actionable takeaways to foster knowledge convergence by alternatively employing selection and synthesis.

**Originality/value** – This paper contributes to the management and social information processing literature emphasizing the role of knowledge convergence emerging from the complex interactions among multiple stakeholders.

**Keywords** Selection, Synthesis, Experiment, Complex adaptive system, Knowledge convergence

**Paper type** Research paper

## 1. Introduction

Collaboration has become an essential ingredient in fostering cohesion between people engaged in deep organizational transformations (Palmberg, 2009; An *et al.*, 2014; Mariano and Awazu, 2021). Among the number of corporate co-creation initiatives flourishing in the past decade, consider IBM, which undertook in 2017 a monthly-long exercise led by the corporate social responsibility team to engage its workforce into the definition of a new roadmap for digital transformation. Similarly, in 2020 BASF, one of the biggest chemical companies globally, started “Embrace,” an initiative targeting 5,000 IT and supply chain employees, aiming to promote a more opener and agile approach.

In this setting, one of the salient collaboration challenges revolves around the concept of knowledge convergence (Weinberger *et al.*, 2007), defined as the ability for individuals to construct a shared interpretation of the transformation through the integration of knowledge and different perspectives (Fulmer and Ostroff, 2016).

Nevertheless, whereas collaboration creates a space for a strategic conversation, it inevitably opens up a level of complexity that has been dramatically increasing in recent years (Morieux, 2011; Janssen *et al.*, 2015). On the one hand, tensions emerge from the conjoint needs of orienting people toward an area of direction usually provided by the top-management but simultaneously integrating knowledge and perspectives of stakeholders from different business functions (Dell'Era *et al.*, 2020; Verganti, 2017; Magistretti *et al.*, 2021). On the other, new forms of collaboration, such as virtual or distributed teams (Diller *et al.*, 2016), have made the process increasingly dynamic and dispersed.

Complex adaptive systems (CAS) theory (Dooley, 1997; Palmberg, 2009) and literature about social information processing (Weick, 1995; Fulmer and Ostroff, 2016) have interpreted the concept of knowledge convergence within complex collaborative setting as a form of social construction through which agents make sense of the changing environment (Canessa and Riolo, 2006). As the sum of non-linear interactions occurring among agents allows the system to self-organize itself (Ashmos *et al.*, 2002; De Toni *et al.*, 2012), from a knowledge perspective, the exchange of information manifests as the emergence of a shared meaning (Stigliani and Ravasi, 2012; Weick, 1995). Collaboration plays a crucial role in enabling the system to maintain cohesiveness and adaptability, enhancing information flow and connections among individuals (Arias *et al.*, 2000; Weick, 1995). However, there is a lack of investigation about how to effectively manage convergence in complex social systems (Fulmer and Ostroff, 2016), leading to a deeper comprehension of the emergence of collaborative patterns from the interactions of individual elements (Ashmos *et al.*, 2002). This is particularly relevant to provide further evidence about a dynamic approach to convergence and emergence (Ashmos *et al.*, 2002; Kozlowski and Chao, 2012), a topic that has been poorly tested in extant research in favor of a more static approach (Fulmer and Ostroff, 2016).

The present study looks more closely at extant literature about group collaboration (Rietzschel *et al.*, 2010; Stasser and Abele, 2020) to answer this gap. We consider selection and synthesis as alternative methods through which individuals in group exchange and converge with respect to their knowledge (Putman and Paulus, 2009; Harvey, 2014) whether by selectively choosing (Putman and Paulus, 2009; Lubart, 2016) or integrating different pieces of information (Kolko, 2010; Harvey, 2014). Differently from extant literature that has mainly focused on their employment within a short-term oriented and static dimension (Paulus and Yang, 2000; Paulus *et al.*, 2018; Stasser and Abele, 2020), this study investigates the influence of the two alternative methods on knowledge convergence throughout a process that protracts over time.

Therefore, the research addresses the following research question: *How do selection and synthesis influence knowledge convergence when people in the organization (as a CAS) collaborate?*

To provide a consistent answer, a longitudinal field experiment (Harrison and List, 2004) has been conducted in four multinational companies part of IDEaLs, an action-research platform that, together with leading organizations, investigates how to engage people to make transformation happen. For each company, 20 participants have been engaged during three workshops over a three-month process to shape their individual and group interpretation of a new strategic direction given by their top management. Inspired by norms governing interactions in flocks of birds (Reynolds, 1987; Kauffman, 1993), a set of simple collaborative tasks have been employed to support participants in building a shared

interpretation of their transformation as a whole. In the longitudinal experiment, selection and synthesis have been separately applied in two companies, each as alternative methods to investigate their influence on knowledge convergence.

This article contributes to a better understanding of the interplay between collaboration and knowledge convergence within the CAS theory (Innes and Booher, 1999; McElroy, 2000; Ashmos *et al.*, 2002). Besides, our study adopts a dynamic approach to the investigation of the emergent properties in a social system (Goldstein, 1999; Beeson and Davis, 2000; Ostroff *et al.*, 2012), a line of research that is still at its infancy in the management literature (Fulmer and Ostroff, 2016).

Second, we provide empirical evidence about the influence of selection and synthesis on knowledge convergence, shedding light on the micro-dynamics which mediate the transition from an individual to a collective level within a dynamic process (Smith and Lewis, 2011; Stigliani and Ravasi, 2012).

In the coming sections, these reflections are deepened. In particular, the study reviews the relevant literature concerning the investigated topic, reaching the definition of the research question. Subsequently, the adopted methodology is presented, followed by the analysis and the study's results. Finally, the main findings and contributions to research and practice are discussed, outlining the limitations and future research avenues.

## 2. Theoretical background

### 2.1 Groups as complex adaptive systems

CAS theory has been increasingly adopted into the organizational realm to understand how social systems behave in uncertain and complex business environments (Dooley, 1997; Palmberg, 2009). Inspired by the emergent collective behavior found in flocks of animals and other bodies of theories, management theorists have defined CAS as systems of agents that interact with each other according to a set of simple rules (Goldstein, 1999; McDaniel, 2008; Will, 2016) and adapt to changing environments, responding to internal and external stimuli as a whole (Kauffman, 1993; Ramos-Villagrasa *et al.*, 2018). The evolution of systems as a cohesive entity results from the interactions between agents that act on each other's behavior (Innes and Booher, 1999; McDaniel, 2008). Scholars have described interactions according to different properties: they are non-linear thus hardly predictable (Lewin and Regine, 1999; Janssen *et al.*, 2015), self-organizing due to different agents' objectives whether resistances (Innes and Booher, 1999; De Toni *et al.*, 2012) and co-evolving since agents' behavior are interconnected among each other (Kauffman, 1993).

During the evolution, different schemes may arise depending on how the entities that compose the system are configured by coalescing together over time (Ablowitz, 1939). In this sense, scholars refer to emergence as a distinctive property of CAS (Goldstein, 1999; Palmberg, 2009; McDaniel, 2008) that arouses as a "whole" from all the local dynamics occurring within the systems (Beeson and Davis, 2000; Ostroff *et al.*, 2012). The interaction among the individual elements at a lower system level allows new patterns or form interaction to manifest as observable elements at a higher collective level (Goldstein, 1999; Kozłowski and Chao, 2012). One of the crucial points of the debate revolves around the dynamic nature of emergence and the relationship between the higher and lower-level attributes of the system (Ostroff *et al.*, 2012; Fulmer and Ostroff, 2016). Kozłowski and Chao (2012) focused on the interplay between bottom-up emergence and its top-down effects on individuals in the system. Several theorists instead contributed to the debate by proposing different forms of emergence (Goldstein, 1999; Corning, 2012). For instance, Kozłowski and Klein (2000) proposed whether the emergence of the parts is due to a specific composition of the elements or their combination and interaction. Bedau (2002) distinguished between weak and strong emergence in relation to how the properties of the whole are clearly explainable and decomposable by examining activities and parts at the micro-level of the

system. Nevertheless, despite the ongoing debate, scholars still call for further investigation of the dynamic and evolving nature of social systems that is usually assumed but not directly tested (Kozlowski and Chao, 2012; Fulmer and Ostroff, 2016) in favor of a more static approach to emergence.

Going further, a different line of literature has focused on the beneficial value of social interactions and collaboration for the adaptability and cohesion of the system while evolving over time (Kauffman, 1993; Ashmos *et al.*, 2002; Palmberg, 2009). A considerable number of studies have explained how collaboration and participation can positively enhance group performance when dealing with complex business issues (Porter-O'Grady, 2015; Hoogeboom and Wilderom, 2020), such as solving problems creatively (McDaniel, 2008) or dealing with large transformational projects (Janssen *et al.*, 2015). Because of collaboration, links among individuals are enhanced (McDaniel, 2008; Will, 2016) through information sharing and knowledge circulation (McElroy, 2000; Ashmos *et al.*, 2002), nurturing collective decision-making (Fisher, 1970; McDaniel, 2008) and ultimately responsiveness to internal and external stimuli (Goldstein, 1999; Palmberg, 2009). Nevertheless, there is still lack of evidence how to effectively managing the trade-off between increasing the number of connections among actors to enhance information flow among individuals (Ashmos *et al.*, 2002) and limiting the potential of conflict in the system due to information overload and different participants' goals (Innes and Booher, 1999; Porter-O'Grady, 2015; Will, 2016). In an effort to solve this debate, recent studies have called for further attention about how simple "rules of engagement" can work as heuristics to orchestrate complex social systems (Ashmos *et al.*, 2002; De Toni *et al.*, 2012; Will, 2016). However, it is still unclear which collaborative mechanisms best allow agents to manage conflict at a local level, ultimately preserving aggregation as a whole toward the same direction of change (Innes and Booher, 1999; Porter-O'Grady, 2015; Will, 2016). Thus, further empirical investigation is needed to identify the micro-interactions to manage knowledge convergence within a dynamic process, an aspect that is still underexplored in the management field (McDaniel, 2008; Palmberg, 2009).

## 2.2 Knowledge convergence

Knowledge convergent properties in social systems rely on some form of social construction (Fulmer and Ostroff, 2016). Social information processing literature (Salancik and Pfeffer, 1978) highlights how agents in the system collectively make sense of the changing environment by processing information (Weick, 1995; McDaniel, 2008; Martin, 2014) and building common knowledge through social interactions (Stigliani and Ravasi, 2012; Mariano and Awazu, 2021). Unanticipated changes in the organizational environment can trigger the systematic processing of external cues and signals as employees attempt to derive meaning from them to confront new events or situations (Weick *et al.*, 2005). Knowledge convergence is described as the social process through which individuals collectively organize individual knowledge into common knowledge (Weinberger *et al.*, 2007; An *et al.*, 2014; Fulmer and Ostroff, 2016). This situation can create a strong cohesion within the group, driving a shared understanding of the group as a whole (Kolfschoten and Brazier, 2013) and conformity in intentions and behaviors (Weick, 1995). In contrast, when signals from the environment are ambiguous, multiple interpretations are likely to develop according to individuals' way of making sense of the changes they are going through (Bowen and Ostroff, 2004; Fulmer and Ostroff, 2016). For this reason, scholars have significantly focused their attention on how the mediation from the individual to the collective dimension is a crucial moment in convergence, as tensions and frictions can hamper the effectiveness of the process (Weinberger *et al.*, 2007; Stigliani and Ravasi, 2012; Nemeth, 2018). In this direction, a significant number of studies in group collaboration have illustrated many methods to support members in a group to move from different viewpoints into a collective result (Putman and Paulus, 2009; Rietzschel *et al.*, 2010; Harvey, 2014). This study

considers selection and synthesis, two methods that provide opposing approaches to knowledge convergence. In the following sections, we will describe the practices and the dynamics underlying the alternative methods, highlighting theoretical gaps that lead us to the research gaps of this article.

### 2.3 Selection

Literature about social psychology and collaborative processes has extensively described selection as a method to make a collective decision by picking from available alternatives (Paulus and Yang, 2000; Paulus and Nijstad, 2003; Rietzschel *et al.*, 2010). In creativity, selection leverages the definition of criteria – such as novelty, originality or feasibility – to identify the “best” option among the available contributions (Putman and Paulus, 2009; Stasser *et al.*, 2012). While novelty is objectively defined as low-frequency ideas from the total pool of ideas (Putman and Paulus, 2009), originality and feasibility are typically determined by group members’ subjective judgment. Therefore, individuals can exclude or include contributions according to their intrinsic quality and preserve ideas’ identity (Paulus and Nijstad, 2003; Terwiesch and Ulrich, 2009).

Previous studies in social psychology have distinguished this method in case groups are resolving a judgmental task, meaning that they cannot formulate a demonstrable correct answer (Laughlin, 2011; Stasser and Abele, 2020). Here, the collective choice is usually derived from group members’ sentiments or opinions and is typically based on expressions of preference and judgments (Stasser *et al.*, 2012). In particular, majority-based rules – such as voting and pooling – are used to aggregate individual preferences (Paulus and Yang, 2000; Putman and Paulus, 2009) and let individuals express commitment (Paulus and Nijstad, 2003), making decisions less heavily influenced by fewer individuals (Abele *et al.*, 2008). For this reason, the preference-driven selection is extensively adopted in social events where large business populations need to be engaged in screening a multitude of contributions, whether during innovation contests or tournaments (Terwiesch and Ulrich, 2009). In preference-driven decision-making, members in the group can highly benefit from interactions among themselves. Whether the involvement of stakeholders having different backgrounds can foster the inclusion of multiple perspectives in the selection process (Paulus and Yang, 2000; Putman and Paulus, 2009), promoting group discussion and negotiation are depicted as a way to build a shared knowledge framework around the discussed topics (Mumford *et al.*, 2003; Laughlin, 2011; Stasser and Abele, 2020). The role of information exchange among group members has been studied as a crucial element in conceiving groups as a whole information processing body (Stasser and Abele, 2020). Experimental evidence has documented the advantages of groups in making better decisions than individuals when unique information is exchanged to inform better collective decisions (Stewart and Stasser, 1995; Abele *et al.*, 2008). However, laboratory studies have shown that decision-making groups tend to focus on common information at the expense of unique information (Stewart and Stasser, 1995; Paulus *et al.*, 2018). Besides, scholars acknowledge cognitive overload is a crucial problem in selection when a large number of perspectives is shared and the creation of a shared understanding is required (Mumford *et al.*, 2003; Kolschoten and Brazier, 2013; Paulus *et al.*, 2018). Although the majority-based techniques are promoted in the literature to effectively address this use by promoting individuals’ engagement (Malhotra and Majchrzak, 2014; Trabucchi *et al.*, 2020), the topic is still controversial since conflicting majorities could arise or minorities could feel under-represented (Terwiesch and Ulrich, 2009).

### 2.4 Synthesis

Scholars have defined synthesis as the practice of integrating, filtering and organizing knowledge as part of a convergent process (Kolko, 2010; Lubart, 2016). While filtering and integration are acknowledged in the context of information overload (Savolainen,

2007; Saxena and Lamest, 2018), in collaboration integrative-synthetic thinking is also conceived as a creative way to resolve conceptual contradictions, by fusing elements or ideas coming from distant domains into higher-order categories to create a new result (Tassoul and Buijs, 2007; Harvey, 2014; Van Oortmerssen *et al.*, 2015). At the heart of all the synthesis methods is the social practice of reflective reframing (Schön, 1983; Weick *et al.*, 2005; Hargadon and Bechky, 2006), through which group members collectively make sense of complex sources of information. More specifically, clustering existing elements, identifying relationships and patterns or forging new connections allow individuals to build a new interpretation of reality (Kolko, 2010; Harvey, 2014; Tassoul and Buijs, 2007) that the members in the group value as a new collective outcome (Hargadon and Bechky, 2006).

During re-framing, scholars have identified the crucial role played by constant dialogue and negotiation (Schön, 1983; Weick *et al.*, 2005; Stigliani and Ravasi, 2012) in supporting the process of meaning-exchange among individuals (Maitlis, 2005; van Oortmerssen *et al.*, 2015), combining knowledge from different domains (Weick, 1995; Heracleous and Barrett, 2001; Mariano and Awazu, 2021) whether solving tensions or paradoxes which could arise during the interplay among agents (Smith and Lewis, 2011; Miron-Spektor *et al.*, 2011; Harvey, 2014). The use of dialectic in synthesis is promoted to integrate contradictory elements (thesis and antithesis) that could emerge when different points of view are discussed (Smith and Lewis, 2011; Harvey, 2014). However, literature acknowledges how conflict is a core element of synthesis to be overcome to bring together different perspectives (De Dreu and Beersma, 2005; Miron-Spektor *et al.*, 2011; Nemeth, 2018).

Nevertheless, the adoption of synthesis can present some flaws during collaboration. The poor management of the collective process – such as converging too quickly – can lead to compromises during negotiation, hampering the depth and the quality of the result (Harvey, 2014; Verganti, 2017). Additionally, an unsolved resolution of paradoxes could lead to a temporary definition of synthesis, causing tension to resurface in the long run (Smith and Lewis, 2011) while the information overload due to the involvement of many different resources can increase complexity and negatively affect the process (Kolfshoten and Brazier, 2013). Having a shared understanding of a topic indeed does not imply that group members agree with that understanding and specific actions to be actualized (Heracleous and Barrett, 2001).

## 2.5 The gap

This study addresses the emerging gaps in the literature concerning CAS theory and methods fostering knowledge convergence through collaboration in a dynamic setting. In the stream of works studying complexity in organizations, the literature lacks empirical investigation about a dynamic approach to the topics of convergence and emergence (Innes and Boher, 1999; Ashmos *et al.*, 2002; Kozlowski and Chao, 2012; Fulmer and Ostroff, 2016). In the group collaboration literature instead, extant studies have conceptualized through selection and synthesis opposing approaches through which individuals in group exchange and converge with respect to their knowledge (Putman and Paulus, 2009; Harvey, 2014; Lubart, 2016). Nevertheless, to the authors' knowledge, in this setting literature is focused mainly on describing these collaborative methods in a short-term oriented and static dimension (Paulus and Yang, 2000; Paulus *et al.*, 2018; Stasser and Abele, 2020), while their influence on convergence within a dynamic and evolving setting has not been fully captured yet.

Thus, this study addresses the following research question: *How do selection and synthesis influence knowledge convergence when people in the organization (as a CAS) collaborate?*

### 3. Methodology

To provide a consistent answer to our research question, a longitudinal field experiment (Harrison and List, 2004) was used as the most suitable approach. The objective of a field experiment indeed is to establish causal relationships by manipulating an independent variable via the administration of a specific treatment in a real-world setting to enhance the generalizability of the experimental findings (Eden, 2017). The choice of such a method was driven by the intention to investigate as closely as possible real organizational dynamics, relying on the comparison of the same object of analysis in an untreated condition and after the treatment actively administered by the researchers (Harrison and List, 2004). This considers the recent trend in a number of management and organizational fields to call for more field experiments to capture behavior within a natural organizational settings (Eden, 2017). Our study compares and analyzes two sets of groups facing the same kind of brief. While the selection was used in the control group as a standard treatment, synthesis was used as a treatment method to foster knowledge convergence among individuals involved in the experiment.

In the following paragraphs, we illustrate the context in which the research was conducted, the staged experimental research design to let people converge over a monthly collaborative process.

#### 3.1 Research context and experiment setting

This study was conducted in four multinational companies, part of the research platform IDEaLs ([www.ideals.polimi.it/](http://www.ideals.polimi.it/)) founded by the School of Management YYY in 2018 to investigate how to engage people to make transformation happen (Press *et al.*, 2021). IDEaLs methodology is a hybrid approach rooted in Mode 2 Paradigm, which builds on action research (Shani and Coghlan, 2018) and design science research principles (Collatto *et al.*, 2018). In fact, it aims to develop artifacts to gain practical and theoretical insights that are valuable both for scholars and practitioners through the development of yearly-based pilot projects. This study took place within this platform and this methodological approach, which we are reporting to give a more comprehensive view on the entire research project and context. Still, the specific study reported in this paper is based on a longitudinal field experiment, as reported at the beginning of this section.

The experiment was performed within four of the six projects developed during the second year of IDEaLs, from September 2019 to September 2020. A three-month process – articulated around a series of collaborative workshops – was jointly designed with partners to support the employees in transforming their individual behavior according to a new strategic direction identified by each organization's managerial core-team. The process was based on Storymaking, an approach conceived explicitly by the IDEaLs research platform to engage individuals in writing and implementing their personal story of change toward a given challenge. Throughout the process, participants worked both independently and in small groups to build an interpretation of the transformational project they were going through. Each group of participants was conceived as a CAS where agents would adapt to the changing environment as a whole entity by developing an individual and shared understanding of the new direction. In this setting, we staged our longitudinal field experiment (Harrison and List, 2004) to investigate how selection and synthesis influence knowledge convergence when people collaborate within a CAS. This research goal intersected with the company's request: to maintain cohesion toward a given direction by allowing people to voluntarily embrace the transformation according to their personal interpretation.

Each convergent method was randomly assigned a dyad of companies: selection in Companies A and B, synthesis in Companies C and D. Such a setting provided an adequate level of external and internal validity. On the one hand, external validity is

enhanced by the possibility of replicating the manipulation in multiple companies (Eden, 2017). On the other hand, internal validity is strengthened because people engaged in the experiment were selected randomly by top-management without following any specific criteria. Comprehensively, we engaged 82 people in a total of 12 collaborative sessions during the longitudinal experiment. For each company, 20 people were involved for the whole duration of the three-months project (Table 1).

### 3.2 The experiment research design

According to the following steps, the process based on Story-making was performed in an analog manner in all organizations. First, the IDEaLs research team and the company core-team jointly identified a strategic challenge related to an ongoing innovation project driving transformation within the organization (Table 2). Despite the different nature of the challenges, the four organizations' directions were homogeneous in need of bringing people on-board to converge toward the direction provided by the top-management.

Participants were engaged over time in writing and actualizing their own transformational story to change their behaviors toward the new company challenge. During a kick-off workshop, the challenge was first introduced to the audience. Then, three collective workshops took place and finally results were shared and discussed with managers and participants in a final Follow-up meeting.

The experiment was staged during the three collaborative sessions located approximately three weeks one from the other and that took place during virtual meetings (Microsoft Teams and Miro were used as communication and collaborative digital platforms). The structure of each of the three group sessions followed a reiterated logic. In each workshop, participants were asked to individually write a piece of their own narrative and take a concrete commitment to actualize their change within the boundaries of the company's new scenario. As a group though, participants were asked to interact according to a set of simple rules that we designed by taking inspiration from the dynamics governing flocks of birds (Lewin and Regine, 1999; Palmberg, 2009). While previous research in biology and computer programming (Reynolds, 1987) acknowledged how few simple interaction rules could govern the flocking behavior of birds, there is growing attention in how these behavioral norms can be translated into actual heuristics governing groups in social contexts (De Toni et al., 2012; Will, 2016). In the next paragraphs, we will illustrate the set of

**Table 1** Descriptive statistics of the projects for each partnering company

Partner	Project length	Collaborative Sessions	Participants	Treatment
Company A	3 months [Feb-Apr 2020]	3 [20 h]	20 [50% women]	Selection
Company B	3 months [May-July 2020]	3 [20 h]	22 [53% women]	Selection
Company C	3 months [Apr-June 2020]	3 [20 h]	20 [45% women]	Synthesis
Company D	3 months [May-July 2020]	3 [20 h]	22 [53% women]	Synthesis

**Table 2** Brief for each partner

Partner	The challenge
Company A	How should I use the 10% of my time to foster innovation?
Company B	How should I change my daily behaviors to make real our company's new strategic vision in my daily work?
Company C	How can I be recognized as an innovative leader within the organization?
Company D	How can I be recognized as a partner for the development of modular and configurable solutions?



interaction rules given to the experiment participants to collaboratively build a shared interpretation of the new strategic direction.

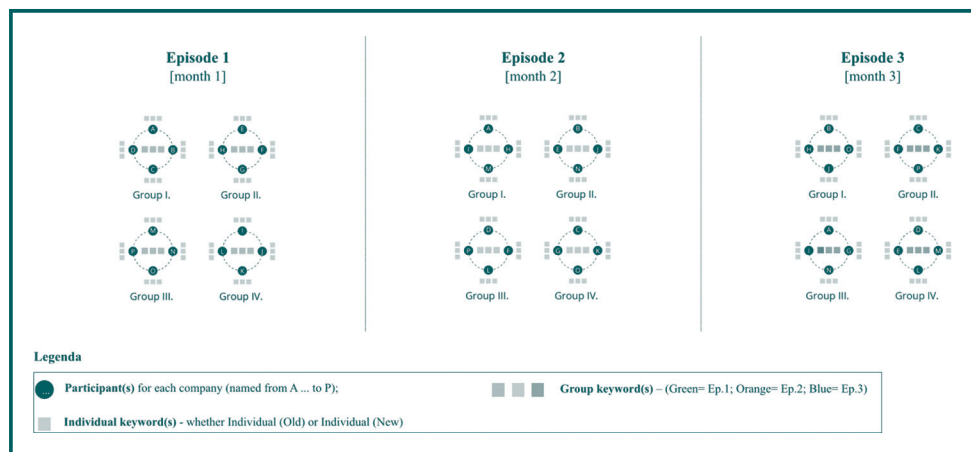
*3.2.1 Managing large groups through local interactions.* Theoretical models proved how global coordinated collective motion in flocks could be generated by simple local interactions between each agent and a few of its neighbors (Reynolds, 1987; Kauffman, 1993). Thus, we managed each sample of participants by letting people interact in small sub-groups according to a set of tasks (Figure 1). Besides writing their own narrative during each episode, participants were asked to identify three keywords summarizing their individual stories. Keywords were meant to represent values, characteristics or beliefs embedded in the individual story. Then, each sample of 20 participants would work in small sub-groups of four individuals to share perspectives and collectively define a set of group keywords out of their individual ones. While sub-groups were hosted in separate virtual rooms during the collaborative activity, they were shuffled over the workshops to favor knowledge contamination.

*3.2.2 Fostering convergence by using selection or synthesis at a local level.* Scholars have highlighted how small appropriate behavioral rules for the flock mates can determine aggregation at the system level (Will, 2016). As when the system moves, agents need to keep separation, alignment and cohesion (Reynolds, 1987), the same sense of convergence was induced in the research experiment when people were collaborating.

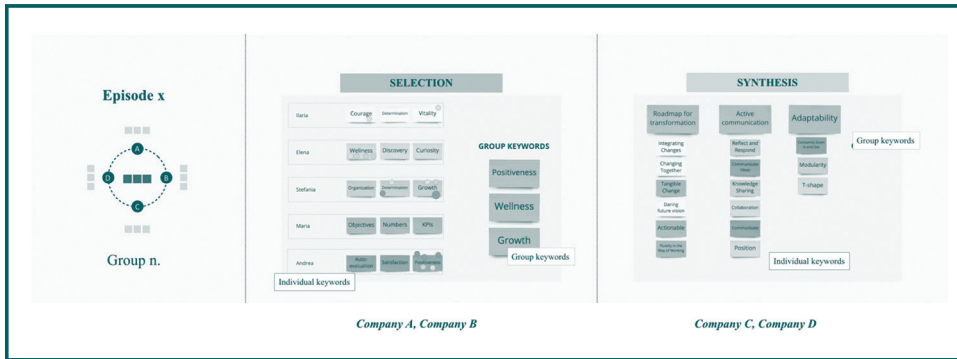
During each episode, sub-groups were asked to converge by collectively defining three group keywords leveraging alternative collaborative methods (Figure 2). In Companies A and B, where selection was used, people were asked to discuss their own keywords with the others and select the most representative ones. Each person could express a maximum of three votes and all individuals keywords were eligible. Then, the three most selected principles were chosen as final ones. In Companies C and D, knowledge convergence was mediated through synthesis. Individuals were asked to present their own keywords and – with other group members – synthesize all the proposed keywords in three comprehensive titles, conceived as the final group keywords.

*3.2.3 Fostering convergence by promoting aggregation at a system level.* Self-coordination has been acknowledged as a crucial property of flocks that allows agents to co-evolve dynamically by interacting one with each other (Reynolds, 1987; Janssen et al., 2015). This allows the whole system to preserve aggregation at a sub-system level and at a general one (Palmberg, 2009). Thus, to allow information to flow across sub-groups, people were asked

**Figure 1** Setting of the experiment through local interactions among participants



**Figure 2** Fostering knowledge convergence in sub-groups through selection or synthesis



to summarize their new piece of narrative with three keywords by choosing from the following categories during each episode.

- *Old individual keywords*: the keywords defined by the same person in the previous workshops;
- *New individual keywords*: the keywords newly generated by the same person during the current workshop; and
- *Group keywords*: the keywords defined by the group in the previous workshops;

Again, we induced this dynamic in each set of participants by keeping fixed the employment of selection and synthesis within each company.

### 3.3 Data collection and data analysis

To provide a systematic comparison of the effects of selection and synthesis on the dependent variable, we operationalized the construct of knowledge convergence according its two main aspects previously acknowledged in the literature (Weinberger *et al.*, 2007; Fulmer and Ostroff, 2016). On one hand, knowledge convergence requires groups to create shared understanding of concepts and words that are related to the task at hand (Weick *et al.*, 2005; Kolfshoten and Brazier, 2013). This implies that group members collectively engage in the definition of a common set of languages and symbols to represent the shared meaning (Bowen and Ostroff, 2004). On the other, knowledge convergence manifests through cohesion since the resembling interpretation of signals drives similar actions or behaviors to occur (Kozlowski and Chao, 2012).

For this reason, our data collection and analysis leveraged words as the primary source of evidence to capture the construction of a shared interpretation among group members (Beckner *et al.*, 2009). Data were collected in the form of actual content created by participants such as individual and group keywords. We transcribed keywords for a total of 48 observation and we classified them according to the three categories of use (i.e. old and new individual keywords, group keywords). This allowed us to assess them in terms of total words entered in the system and new words used by participants as individuals or groups during each episode.

Then, two main kinds of analysis were performed to assess over time knowledge convergence in terms of shared understanding and cohesion (Weick *et al.*, 2005; Kolfshoten and Brazier, 2013). First, words frequency analysis was used to depict emerging regularities in word usage (Beckner *et al.*, 2009), when participants were building a shared understanding of the given challenge in both sets of companies. For each episode, we assessed maximum and average word frequency. This would rely on the

assumption that, if people converged more around some key concepts, some keywords would have been used more frequently than others along the process. Second, we used word counting analysis (Christensen *et al.*, 2017) to assess the number of times that individuals used keywords individually or collectively generated to describe their piece of narrative during each episode. This would enabled us to understand if individuals were more inclined to select and propagate individual or group pieces of information from one episode to another, whether by fostering or dissipating a sense of cohesion in the group.

Furthermore, additional qualitative sources of data served to corroborate such evidences from previous analyses. Our process approach significantly relied on qualitative evidence to embrace the longitudinal dimension of our experimental research (Langley *et al.*, 2013), answering a recent call to increase management scholars' sensitivity to the importance of "theory-method" fit (Gehman *et al.*, 2018). This process approach indeed explicitly incorporates the temporal progression of activities within the investigation of organizational dynamics (Gehman *et al.*, 2018). For this reason, over the research, a rich heterogeneity of data was collected from different sources within the time span of the longitudinal experiment such as transcriptions from video recordings and meetings, feedback provided by participants over the process and field notes taken by researchers throughout the whole project. Such qualitative evidences were analyzed longitudinally as codes in relation to the emerging patterns, such as regularities in the use of words by participants. This additional round of coding helped us in having a more comprehensive understanding of the rationale behind participants' tendencies to use words while converging according the alternative methods (Table 3).

#### 4. Results

This study investigates how selection and synthesis influence knowledge convergence when people in the organization collaborate within a CAS during a transformational project. Based on our analysis, two sequential layers of results are presented. First, we provide evidence about how selection and synthesis differently influenced knowledge convergence

**Table 3** Data sources

<i>Data types</i>	<i>Use in the analysis</i>
<i>Recordings of collaborative sessions [with transcription]</i>	
Story-making collaborative sessions	The transcriptions of the recordings were analyzed in terms of emergence of recurring themes and their evolution over time Feedback and insights from participants were coded to depict individual perceptions about the process
12 workshops	
80 h	
48 observations	The kick off and the follow ups were helpful to gather additional feedback about the experience from managers and employees
24 h	
Additional sessions: kick off and follow up	
8 sessions	Keywords were classified in terms of individual keywords (old and new) and group keywords. For each episode, we assessed the totality of new terms entered in the system, new word used, maximum and average frequency
8 sessions	
<i>Content from collaborative sessions</i>	
Individual keywords	Through word counting we assessed individual tendency to select individual or group keywords from one episode to another
First episode: 700 data points	
Second episode: 710 data points	
Third episode: 708 data points	During the closing IDEaLs research meeting, we presented and discussed the results of this study with organizations' core-teams, gathering feedbacks and additional insights
Group keywords	
First episode: 144 data points	
Second episode: 144 data points	
Third episode: 144 data points	
<i>IDEaLs research meetings</i>	
Platform-level sessions	
1 Research meeting	
3 h	

throughout the process by capturing the emergence of recurring keywords and themes. Second, we illustrate how the two methods have differently influenced people to transmit in the long run different pieces of information (i.e. individual or collective keywords) during social interactions.

#### 4.1 Comparison of patterns emergence in selection and synthesis

In companies where selection was employed, it emerges from word frequency analysis (Table 6) how the individual dimension played a fundamental role throughout the longitudinal experiment. Indeed, most of the words entered into the system across the three episodes belong exclusively to individuals. Instead maximum frequency tends to rise over time, suggesting that few keywords were increasingly adopted by a number of individuals thanks to local interactions. For instance, in Company A, during the first and the second episode, the maximum frequency is 12, while in episode 3 is 13. Then, the average frequency of used words tends to decrease, indicating how individuals converged on fewer words. This would suggest that the application of selection helped some concepts to gain greater prominence over time, giving higher visibility to the keywords composing the emerging pattern.

With this regard, in Companies A and B, keywords move from a wider set of words to a smaller, more homogeneous set of words, even if variety still occurs in the end. Interestingly, some keywords, such as “Change” and “Customer” (Company A) and “Cooperation,” “Determination” and “Growth” (Company B), occurred transversally across all three workshops as the most frequent ones (Table 4).

This would suggest that participants collectively tended to carry forward a narrow set of terms to describe the organizational transformation they were facing as a social system. From a semantic perspective, keywords used in the first two companies suggest more abstraction and openness in meaning than those used in Companies C and D. The selection method seems to have oriented groups to choose several umbrella concepts, words with a broad meaning that intrinsically include different perspectives. To find a common agreement over time, participants seemed more likely to select the common

**Table 4** Selected excerpts from selection

Company	Episode 1	Episode 2	Episode 3
Company A	<p>[Group 2]  <i>Ind.4:</i> "... I will select <b>Change</b> because in the end is what we are all striving for in this project."  <i>Ind.2:</i> "Yeah, maybe at different levels. ...<b>Change</b> as individuals and as organization."  <i>Ind. 1:</i> "It's also about <b>changing</b> our approach, no?"</p>	<p>[Group 3]  <i>Ind. 1:</i> "... <b>Change</b> is a strong one."  <i>Ind.3:</i> "Quite general though."  <i>Ind. 5:</i> "... I think it depends on the context. For instance, in this phase maybe is more an <b>Evolution</b>"</p>	<p>[Group 1]  <i>Ind.6:</i> "... What I like about <b>Change</b> is that is still valid. We still are going through a transition."  <i>Ind.3:</i> "... So it refers to the organization."  <i>Ind. 7:</i> "... To me it is a personal imperative. I need to <b>change</b> my way of working, otherwise I won't be able to deliver results."</p>
Company B	<p>[Group 4]  <i>Ind. 1:</i> "... I was reflecting about our stories. ... <b>Strength</b>, <b>Courage</b>. ... They are all bold terms I think."  <i>Ind. 2:</i> "I agree. I will select <b>Determination</b> because it has this kind of peculiar nuance, you know?"</p>	<p>[Group 2]  <i>Ind. 3:</i> "What about <b>Passion</b>?"  <i>Ind.6:</i> "Yeah. It is a nice one. ... I like also <b>Determination</b> because is more pragmatic."  <i>Ind. 5:</i> "For sure they are connected!"</p>	<p>[Group 4]  <i>Ind. 6:</i> "... We need to be concrete, you know? And persistent in delivering small results."  <i>Ind. 1:</i> "I like <b>Determination</b> because it links our commitments."  <i>Ind. 5:</i> "Yeah. That's nice."</p>

elements among them, sacrificing the end result's originality to ensure a greater sense of inclusion of group members.

"I think that selection has made the values we all unanimously share stand out [...] this was useful because it gave us an awareness of what brings us together."

"[...] over the discussions, we attempted to prioritize the key elements for the transformation [...] perhaps the ones we were most likely to agree on were the most predictable."

"[...] the important capability is to bring people on-board on your proposal to acquire more votes, because in the end is the majority that decides. "

Contrarily, results coming from the application of synthesis on knowledge convergence (Table 5) show a higher focus on the collective dimension since new words entered the process were generated in group sessions. Maximum word frequencies in Companies C and D are significantly lower than in Companies A and B, touching a maximum number of 9 (Company C) and 7 (Company D). This seems to suggest that individuals tended to agree on a larger set of keywords, which would vary from one episode to another, causing patterns related to keywords' usage to emerge less explicitly in comparison to Companies A and B. Moreover, average frequencies are significantly lower than in the two previous cases, suggesting that people tended to iteratively converge toward a wider set of words generated in the group. The number of words used by groups is quite stable over time, while synthesis reports a slightly greater tendency to add new words during the process.

The sum of keywords in Companies C and D move from a wider set of words to a smaller, more homogeneous set of words, even if variety still occurs across the three episodes. Contrary to the previous case, in synthesis occurrence of keywords seems to be more volatile, as the most recurring keywords that emerge during each episode are always changing. For instance, in Company C, words such as "Innovation," "Courage" and "Attitude," while in Company D "Change," "Methodology" and "Daring" are the most cited exclusively in single episodes.

**Table 5** Selected excerpts from synthesis

Company	Episode 1	Episode 2	Episode 3
Company C	<p>[Group 1]  <i>Ind. 1:</i> "... Empowerment is the result of a courageous introspective activity."  <i>Ind. 2:</i> "I like the "Self-Leadership" though, because I think it encompasses a lot your elements. You need to <i>trust yourself</i> and be <i>courageous</i>."</p>	<p>[Group 2]  <i>Ind. 3:</i> "... I think that <i>Passion</i>, <i>Empower</i> and <i>Courage</i> speak about <i>Personal Growth</i>. It is a way to challenge yourself no?"  <i>Ind. 1:</i> "It is similar to <i>Self-Leadership</i>, yeah..."  <i>Ind. 5:</i> "I like the idea of <i>Embracing courage for yourself</i>..."</p>	<p>[Group 2]  <i>Ind. 6:</i> "... <i>italicness</i> is a nice one. It is interesting that when you lead yourself you need to be convinced."  <i>Ind. 3:</i> "Yeah, like <i>Breaking through</i> that links <i>Courage</i> and <i>Self-Leadership</i>."  <i>Ind. 7:</i> "I like it because it gives a sense of direction. You lead yourself toward something, no?"</p>
Company D	<p>[Group 4]  <i>Ind. 1:</i> "It's also about daring perspectives that we are not used to have. What about then <i>Daring</i>, <i>daring vision</i>?"  <i>Ind. 2:</i> "<i>Vision innovation</i>?"  <i>Ind. 3:</i> "<i>Daring future</i> or <i>Daring vision for the future</i>?"</p>	<p>[Group 2]  <i>Ind. 4:</i> "So the <i>Daring Action</i> seems to kind of <i>Changing perspective</i>?"  <i>Ind. 3:</i> "Yeah, it's more like <i>Think Differently</i>. Because when we say <i>Daring Action</i>, we all talking about doing things differently, right?"</p>	<p>[Group 4]  <i>Ind. 5:</i> "... If we just say something like <i>Be the change</i> that talks toward like <i>Action</i> or <i>Taking ownership</i> and things like that. ... But it doesn't have the <i>Inspiration</i> and the <i>Daring</i> and things like that."  <i>Ind. 1:</i> "<i>Commit to the change</i>?"  <i>Ind. 5:</i> "How about "<i>Inspired change</i>?"</p>

Evidence suggests that synthesis triggered members in the group to continuously negotiate meaning to integrate distant perspectives, fostering the generation of different sets of keywords throughout the process. From a semantic perspective, keywords used to describe the group's collective outcome suggest more specificity and depth of meaning. While participants were crafting different utterances to effectively capture the variety of perspectives on the table, the intrinsic dynamicity of the process caused the continuous construction and deconstruction of words. Several participants indeed reported the common impression of continuous reworking of the content according to different viewpoints and the lack of an explicit sense of convergence over the episodes.

"It was like if each time we were deconstructing what we had done in previous episodes to recombine it with new meaning[...] A sort of continuous flow, you know?"

[...] maybe some recurring concepts were circulating[...] Every time they had a different shape based on the people who participated in building them."

"What I perceive is that there was not visible convergence[...] The coverage of topics was quite broad throughout the journey[...]"

#### 4.2 Propagation of individual or group keywords over episodes

During the collaborative process, selection and synthesis triggered different ways to diffuse information across different groups (Table 6–7). In particular, evidence suggests how selection leads people to propagate into subsequent interactions keywords that they generated individually. Contrarily, synthesis seems to foster a tendency in participants to promote during collaborative sessions keywords generated during group activities.

With this regard, Table 8 illustrates the percentages of words – within the totality of all the ones chosen by participants over the episodes – belonging to the individual or collective category. Results about selection suggest that – over time – people were more inclined to select keywords generated by themselves. This is evident in Company A, where 52% of keywords selected by participants in episode 2 to describe their piece of narrative were the ones previously used to define their first story chapter. In episode 3 the trend is quite stable: 49% of the principles used to define the third chapter of the story were generated individually during the previous steps. Although this same evidence is not visible in Company B, the majority of words used by participants were generated individually from scratch from one episode to another.

**Table 6** Word frequency analysis in *selection* over the episodes

Company C	Episode 1		Episode 2		Episode 3	
	Individual	Group	Individual	Group	Individual	Group
<b>Synthesis</b>						
Entry words	53	60	44	60	36	54
New words	46	0	14	0	7	0
Maximum frequency	3	12	4	12	5	13
Average frequency	1,15	1	0,68	0,7	0,54	0,7
Total words	46	6	31	7	20	6
<b>Company B</b>						
Entry words	66	66	66	66	60	60
New words	56	0	22	3	19	1
Maximum frequency	3	6	5	11	6	15
Average frequency	1,07	1	0,8	0,81	0,59	0,59
Total words	52	10	41	11	39	9

**Table 7** Word frequency analysis in *synthesis* over the episodes

Company C	Episode 1		Episode 2		Episode 3	
	Individual	Group	Individual	Group	Individual	Group
Synthesis						
Entry words	57	50	49	60	59	60
New words	55	9	12	5	19	5
Maximum frequency	2	5	6	9	6	6
Average frequency	0,88	0,47	0,47	0,57	0,56	0,57
Total words	54	6	19	12	34	12
Company D						
Entry words	57	57	54	54	50	54
New words	53	10	32	10	20	9
Maximum frequency	2	5	3	7	3	5
Average frequency	0,9	0,9	0,4	0,4	0,37	0,37
Total words	53	12	44	11	40	11

**Table 8** Analysis of the tendency (%) to which individuals selected keywords (i.e. old individual keywords, new individual keywords, group individual keywords) over episodes

Company	Method	Episode 2			Episode 3		
		Old Ind. keywords (%)	New Ind. keywords (%)	Group keywords (%)	Old Ind. keywords (%)	New Ind. keywords (%)	Group keywords (%)
Company A	Selection	52	20	28	49	21	30
Company B	Selection	22	48	30	22	53	25
Company C	Synthesis	16	19	65	16	26	58
Company D	Synthesis	6	53	41	14	36	50

On the contrary, through synthesis people were more likely to bring forward keywords previously defined in group, even if in Company D such method seems to trigger individual ideation as well. Overall, this suggests that most participants in Companies C and D preferred to summarize their individual pieces of narrative by using keywords generated in the group.

Qualitative pieces of evidence (Table 9) were used to provide insights about participants' perceptions and feelings when bringing forward different kinds of keywords from one episode to another. Some participants declared that the selection helped them collectively identify the concepts unanimously accepted by the majority, fostering awareness and sense of belonging. Despite acknowledging the validity of these elements, many stated that they preferred to bring forward individual terms to subsequent episodes since they perceived them more personal and meaningful. Thus, it seems that selection helped participants develop a shared understanding of the organizational transformation at a system level, even if magnifying their sense of affection toward the knowledge generated individually during the collaborative process.

Contrarily, individuals from Companies C and D seemed more likely to bring forward keywords previously generated in the group. Participants declared that the creative effort necessary to integrate various perspectives into a collective outcome helped them develop a deep sense of attachment toward the result produced within their own sub-group. Rather

**Table 9** Selection of qualitative excerpts about the tendency to propagate individual or collective keywords over episodes

Second-order code	Evidences from selection	Evidences from synthesis
<i>Propagation individual keywords</i>	<p>"I accept what the majority has chosen . . . they are important values that I share. The fact is that my values do not change . . . I carry them with me the majority of times, I think."</p> <p>". . . I varied once so as not to be repetitive, but if I had been on my own throughout the whole project I would have always kept <i>Passion, Determination and Courage</i> [individual keywords]."</p> <p>"I think a distinction needs to be made. . . the words that came out at the group level make sense for the change the company is facing . . . [during the process] I chose other words because they seemed closer to the type of challenge I was facing."</p>	<p>". . . I preferred <i>Brave</i> [individual keyword] because it narrowed down a more personal aspect of what I was facing. . . the group one was <i>Daring Action</i>"</p> <p>". . . [during the process] we evolved together but keeping our individuality . . . You need to understand your vertical to understand how to fit into the whole."</p> <p>. . . Your viewpoint is important because perhaps you are moving ahead of others and you can add nuances to others' perspective . . . I proposed "<i>Ecosystem</i> [individual keyword]"</p>
<i>Propagation collective keywords</i>	<p>". . . The emerging similarities surprised me . . . Discovering that people from different areas believe in a very similar vision of the future was a surprise."</p> <p>". . . When I took the keywords brought by other colleagues it was because I tried to be inspired by what others had done . . . I chose the ones that were most in line with what I thought . . ."</p> <p>"During the last few episodes, there were more recurring values because most people were voting for them . . . I think it happened because they are the essential values in our company, those from which each of us must start to change ourselves . . ."</p>	<p>. . . Create a collage out of snippets of individual stories, making the individual drives and struggles sharable or collectively ownable . . .</p> <p>". . . with <i>Fluidity in the way of working</i> [group keyword] I think we captured all. <i>Strategic Thinking</i>" and <i>Collaboration</i> [individual keywords] then seemed to me describing just some facets of the same concept. . . in the second episode, I choose again <i>Fluidity in the way of working</i> yeah . . .</p> <p>"[Synthesis] is confronting because you have find expressions that make sense to everyone and viewpoints are different . . . the final outcome is stronger because it encapsulates everyone's perspectives. . ."</p>

than viewing group and individual keywords as two separate entities, they reported the impression that their own contribution was an embedded part of the result.

## 5. Discussion

Taking a CAS perspective, this study leveraged a longitudinal field experiment to explore how selection and synthesis influence knowledge convergence when people collaborate over time. We collected different data sources over a total of 48 observations that involved 4 multinational companies seeking to engage participants toward a new transformational direction. Inspired by the rules governing birds' flocks, we designed and used a set of collaborative tasks over different sessions to let people converge toward a shared interpretation of the transformation and compare the influence of selection and synthesis.

By combining word frequency analysis, word counting analysis and a qualitative process approach, we established that knowledge convergence in a CAS is differently affected by the two used methods. The analysis revealed that selection triggers the emergence of keywords usage at a general system level, bringing more abstract and open concepts to the surface. Besides, through selection people seem to develop a strong emotional attachment to self-generated information, being more likely to disseminate it in the long run. Contrarily, despite the emergence of patterns in synthesis occurs less explicitly due to continuous reworking of concepts through dialogue, people are inclined to develop



affection toward the group outcome and propagate into subsequent interactions knowledge generated collaboratively.

### 5.1 Theoretical implications

This study contributes to two bodies of literature concerning the concept of emergence in CAS theory within an organizational setting (Lewin and Regine, 1999; McElroy, 2000; Palmberg, 2009; Janssen *et al.*, 2015) and the management of knowledge while fostering convergence through collaboration (Weinberger *et al.*, 2007; Rietzschel *et al.*, 2010; Harvey, 2014).

While extant literature acknowledged how collaboration and participation could positively enhance adaption and cohesion in complex social systems (Palmberg, 2009; Ashmos *et al.*, 2002; Will, 2016), still little research has fully embraced a dynamic approach to test the convergent properties during an emergent process (Kozlowski and Chao, 2012; Fulmer and Ostroff, 2016). Our study offers empirical evidence to this topic by investigating how selection and synthesis ultimately trigger two alternative configurations of patterns (Ashmos *et al.*, 2002; Weinberger *et al.*, 2007) and forms of emergence (Goldstein, 1999; Kozlowski and Klein, 2000; Corning, 2012) as illustrated in Table 9.

Leveraging the election of specific alternatives according to individual preferences (Laughlin, 2011; Stasser and Abele, 2020), selection fosters higher recurrence of small set of keywords as few terms gained resonance over time. Herein, umbrella concepts were used by people to converge toward abstract and open keywords that intrinsically include different perspectives. We build on Bedau's research (2002) suggesting how selection triggers a form of weak emergence since the patterns arising at a higher-level have a more explicit connection with the elements at a lower-level. The creation of the whole group's shared understanding manifests more visibly at a macro-level (Goldstein, 1999; Bowen and Ostroff, 2004), where the usage of recurring and common keywords seems to fuel a more general and stable form of convergence over time.

Leveraging on the continuous reframing of meaning (Weick *et al.*, 2005; Hargadon and Bechky, 2006; Stigliani and Ravasi, 2012), such as the iterative deconstruction and integration of perspectives over time, the influence of synthesis manifests reversed dynamics in comparison to the ones triggered by the previous method. Herein, the protracted dialogue among individuals (Schön, 1983; Weick *et al.*, 2005) leads to a form of strong emergence (Bedau, 2002), where new specific and enriched keywords are continuously generated by the individuals engaged in the process. As a result, a volatile equilibrium seems to emerge (Smith and Lewis, 2011), where tensions among different perspectives (De Dreu and Beersma, 2005; Miron-Spektor *et al.*, 2011; Harvey, 2014) tend to resurface and be absorbed within each sub-group dynamically. Therefore, in terms of convergence, the creation of a shared understanding of the new direction remains at a more local level (Goldstein, 1999; Kozlowski and Chao, 2012), as the knowledge is more contextual to the group that generated it (Bowen and Ostroff, 2004).

Finally, our study suggests that the mere investigation of observable patterns emerging at a higher-level (Ashmos *et al.*, 2002; Weinberger *et al.*, 2007) is not sufficient for a comprehensive understanding of the system in terms of convergence. Following a more static approach, previous literature has highlighted observability as a key component of the system to identify how a general interpretation of a changing context emerges in a system (Goldstein, 1999; Palmberg, 2009; Ostroff *et al.*, 2012). Nevertheless, we suggest that this could lead to a misleading reading of the level of convergence of the system, as the mere fact that a set of shared information emerges more visibly at a macro-level does not imply that individual agents are positively and profoundly connected with that. We propose a shift in attention to examine how information is propagated within the system over time because of different forms of interaction. While selection seems to foster people's tendency to

propagate information generated individually, synthesis seems to trigger the willingness to share information generated collectively. Our study advances theory by expanding the view of emergence in the light of collaboration (Ashmos *et al.*, 2002; De Toni *et al.*, 2012), suggesting how alternative ways of processing knowledge can promote people's willingness to inform the construction of a common interpretation with different sources of information (Table 10).

Second, this study brings a novel insight into the literature about selection and synthesis within a dynamic, collaborative process, posing a specific focus on the filtering of knowledge (Lubart, 2016) while moving from the individual into the collective dimension. Coherently with previous literature, we know that collaboration can positively influence performance within CAS by enhancing connections and information flow (McElroy, 2000; Ashmos *et al.*, 2002; Ramos-Villagrasa *et al.*, 2018). We advance the reflection that – rather than merely looking at collaboration in terms of information exchange (Goldstein, 1999; McDaniel, 2008; Janssen *et al.*, 2015) – it is crucial to understand how individuals collectively process different pieces of information circulating within the system and how they emotionally relate to them. With this regard, we suggest a different perspective on the role played by tensions and conflict arising when individuals collaborate to come up with a collective decision (Nemeth, 2018). In particular, we advance the hypothesis that the opposing approaches to overcome tensions when processing alternatives through selection or synthesis (Lubart, 2016; Paulus *et al.*, 2018) could have influenced people's feeling of affection toward different kinds of information and their tendency to propagate them in the long run. Hence, we address those studies which have depicted tensions as something to be overcome while collaborating (De Dreu and Beersma, 2005; Miron-Spektor *et al.*, 2011; Harvey, 2014), while focusing on the counterintuitive idea that they could work as enablers for knowledge convergence because they challenge people to seek deeper connections to integrate distant ideas.

With this regard, through our findings from selection, we confirm what previous studies about collective choice have pointed out in literature (Paulus and Nijstad, 2003; Rietzschel *et al.*, 2010). In fact, although the method is traditionally used to preserve ideas' intrinsic identity (Terwiesch and Ulrich, 2009), in a group the collective choice tends to converge around common knowledge (Stewart and Stasser, 1995; Paulus *et al.*, 2018). Additionally, we emphasize how the presence of differences among individual perspectives within an exclusion-based process (Paulus and Yang, 2000; Abele *et al.*, 2008; Stasser *et al.*, 2012) can lead people to overcome this issue by orienting the decision toward those contributions that as large could include more viewpoints. According to literature about synthesis, integrative-thinking requires fusing distant perspectives to create a novel outcome (Kolko, 2010; Harvey, 2014). Therefore, in this case, tensions played a key role to the extent that their resolution conveyed to individuals a greater sense of depth toward the collective outcome.

To conclude, we want to emphasize how, during an evolving collaborative process, seeking common elements among different perspectives involved is not the only way to seek knowledge convergence (Tassoul and Buijs, 2007; Kolko, 2010). In fact, the emerging

**Table 10** Influence of selection and synthesis on emergent and convergent properties of the system

<i>Collaborative method</i>	<i>Level of knowledge emergence</i>	<i>Knowledge convergence</i>	<i>Propagation of knowledge</i>
Selection	<i>Macro-level</i> (Weak form: Abstract and Open Keywords)	<i>General and stable</i>	Tendency to propagate information <i>generated individually</i>
Synthesis	<i>Micro-level</i> (Strong form: Specific and Enriched Keywords)	<i>Local and dynamic</i>	Tendency to propagate information <i>generated collectively</i>

differences and contradictions give room to the system's agents to seek knowledge convergence by orienting collective decisions or forging new deeper and more meaningful connections.

## 5.2 Practical implications

Whereas the nature of collaboration is increasingly becoming more complex (Lewin and Regine, 1999; Janssen *et al.*, 2015), managers in organizations are required to ensure a sense of convergence toward the same direction of change despite the inclusion of numerous and different viewpoints (An *et al.*, 2014; Verganti, 2017; Dell'Era *et al.*, 2020; Mariano and Awazu, 2021). In this study, we translated flocks' self-regulatory principles into three simple collaborative tasks to foster knowledge convergence during organizational transformation project. We understood that managing large groups through local interactions, fostering a sense of knowledge convergence at a sub-group level and promoting aggregation at a system level by triggering collective knowledge propagation could help practitioners to infuse a sense of cohesion into their employees throughout a longitudinal process. In this study, we applied these heuristics in four multinational companies, helping them in fostering people to converge around a shared interpretation of a given challenge driving organizational transformation. However, this could also be useful for project leaders that need to manage distributed team interactions tackling complex tasks or for managers who organize corporate social initiatives such as tournaments or competitions where a large number of participants are engaged.

Secondly, the result of this study provides actionable insights to help practitioners effectively use selection or synthesis according to specific situations and goals during collaboration, considering possible advantages or drawbacks in relation to emergence. Based on our results, we suggest the employment of selection to test consensus of the whole group of individuals by identifying the overarching concepts that are unanimously accepted as the project evolves. Additionally, selection is helpful to let emerge those concepts worth exploring more in depth. However, our results suggested how selection can enhance the disconnection between the individual and the collective dimension. Therefore, we highlight as a point of attention for practitioners the necessity to check during follow-up the coherence between the collective decision mediated through selection and the actual individuals' commitment in pursuing it. Finally, we suggest the use of synthesis to generate ideas that integrate the viewpoints of different people so as to enable the coalescence of a larger group around the same idea. Then, synthesis is helpful to deepen concepts that might be too abstract and therefore taken for granted. With this regard, tensions occurring when different perspectives are brought together should be leveraged – rather than avoided – to challenge emerging ideas and deepening their meaning by integrating new aspects.

## 6. Limitations and avenues for further research

We acknowledge that our exploratory study about the influence of selection and synthesis on knowledge convergence within a CAS is not free from limitations that also provide future research opportunities. First, studies in a real-based setting could naturally involve some practical problems. Due to the longitudinal nature of the experiment, we could not control for all contextual factors such as prior knowledge among participants or informal interactions among them. Furthermore, we are aware that our study did not consider individual characteristics like general intelligence or social value orientation that might have impacted individual and group performances. Also, neither group differences like hierarchical level or organizational culture conditions have been considered. Leveraging on these, future research might consider using alternative manipulations that may yield stronger evidence.

Then, we illustrated how knowledge convergence could be differently influenced by using selection and synthesis, nurturing a sense of cohesion among agents. In particular, we have presented a set of collaborative tasks that can be employed as simple engagement rules to

foster knowledge convergence in complex social groups within a corporate setting. Therefore, we suggest it would be valuable to investigate their effects in other collaborative or different organizational contexts to further corroborate the results' generalizability.

From a methodological perspective, it seems important to mention two additional notes. First, for each partnering organization, we relied on a limited sample of employees. Hence, future experimental research could provide further reflections on the possible tendencies to vary the sample size considered to a larger number of participants. Second, it could be interesting to employ other kinds of data analysis to investigate how word patterns emergence when individuals collaborate over multiple interactions over time. While we partially leveraged word frequency and word counting, other kinds of linguistic analysis – such as semantic analysis – could be useful to deeply capture the meaning exchange among individuals, providing a deeper understanding of the phenomenon.

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