

# How do you frame ill-defined problems? A study on creative logics in action

Cristina Tu Anh Pham  | Stefano Magistretti  | Claudio Dell'Era 

School of Management – Politecnico di Milano, Milan, Italy

## Correspondence

Cristina Tu Anh Pham, School of Management – Politecnico di Milano, Milan, Italy.  
Email: [cristinatu.pham@polimi.it](mailto:cristinatu.pham@polimi.it)

Problem framing is pivotal to fostering knowledge and innovation, especially in the modern environment where problems are often ill defined. However, the managerial literature has thus far mainly addressed problem framing from an outcome perspective, overlooking the processes that lead to the outcomes. A common view is that the complexity, ambiguity and uncertainty of ill-defined problems call for a creative process. Therefore, through ethnographically observing six design thinking workshops, this study adopts a qualitative approach to explore the problem framing creative process. Specifically, we unpack three thinking modalities involved in the creative process (i.e. creative logics) of problem framing: analogical reasoning, associative thinking and abductive reasoning. We suggest that individuals enact these through seven creative operations. In addition, we link these creative operations to two types of problem framing outcomes: referenced frames and crafted frames. From a practitioner perspective, this study casts new light on the importance of problem framing for creativity and innovation, highlighting the ways in which individuals operationalize the creative logics to frame ill-defined problems as original problems worth solving.

## KEYWORDS

abductive reasoning, analogical reasoning, associative thinking, creative logics, creativity, design thinking, ill-defined problem, problem framing

## 1 | INTRODUCTION

In the wake of the 2015 Fashion Week in Milan, Gucci, known for its clean-cut lines and elegant simplicity, wowed the entire fashion industry by introducing a concept not only new to the *maison* but also the world: gender-neutrality. This took place as Gucci transitioned from the decade-long creative direction of Frida Giannini to Alessandro Michele, her former assistant. Having worked for Gucci for 12 years, people in the industry expected Alessandro Michele to follow his predecessor's lead. Instead, to everyone's surprise, he put Giannini's legacy aside in just 5 days and re-thought many unquestioned pillars of fashion (Koblin, 2015). Fast forward to today, Alessandro Michele is

now one of the most iconic creative directors and author of many innovations in the fashion industry. Behind his success is the ability to think creatively while interpreting the messy, complex and ill-defined environment, 'he is an eccentric who thrives from clutter' (Wintour, 2016, 00:02:57<sup>1</sup>). The Alessandro Michele example draws attention to the interrelation of two concepts. The first is problem framing, that is, interpreting and schematizing the environment into problem frames (Beckman, 2020; Cornelissen & Werner, 2014). The second is the creative process in the sense of Rhodes (1961), namely, the way individuals process and think of information creatively, hence creative thinking (Runco & Chand, 1995). Continuing with the gender-neutrality example, Michele approached the male versus female

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2023 The Authors. *Creativity and Innovation Management* published by John Wiley & Sons Ltd.

concept using creative thinking, and in rethinking the concepts, a new problem emerged: Is it necessary to distinguish genders?

The link between problem framing and the creative process should come as no surprise, long hinted at by scholars in several communities. Recalling Einstein and Infeld (1938), 'The formulation of a problem is often more essential than its solution [...] To raise new questions, new possibilities, to regard old problems from a new angle, requires imagination' (p. 83). Yet, how the creative process unfolds in framing ill-defined problems remains an open question. Indeed, untangling the interrelation between problem framing and the creative process in its lower-level aspects can inform scholars on how problem framing can be achieved, advancing the role of creativity in problem framing and consequently innovation.

Problem framing entails building mental representations that simplify the problem (Gavetti et al., 2005, 2012; Thagard, 1996); thus, a clear mental representation of the problem goal, the assumptions and the paths towards a solution prior to the solving effort (Holyoak et al., 1984). Indeed, a better problem frame should lead to a better solution (Harvey & Kou, 2013; Reiter-Palmon & Murugavel, 2018).

However, Cornelissen and Werner's (2014) literature review shows that problem framing has mainly been investigated from the outcome perspective. While finding consensus on two types of outcomes—referenced frames (RF) and crafted frames (CF) (Cornelissen & Werner, 2014)—less is known in terms of how these come about. For this reason, Posen et al. (2018) invited scholars to investigate the way problems are formed and the processes leading to these outcomes. Given that innovation is increasingly tasked with ill-defined problems (Abdulla et al., 2020), their complexity, uncertainty and ambiguity are implied (Dunne & Dougherty, 2016; Mumford et al., 1994). Under these conditions, the creative process is not only paramount (Harvey & Kou, 2013; Reiter-Palmon et al., 1997), but allows moving confidently across different levels of abstraction (Berg, 2019; Mueller et al., 2014).

Some scholars suggest that the creative process—intended as creative thought (Rhodes, 1961; Runco, 2004)—involves the cooperation among spontaneous and evaluative processes (e.g. Beaty et al., 2015). Others define it as the combination of unconscious and conscious processes that follow similar logics, with a difference in conscious awareness (e.g. Gilhooly, 2016). Past studies on problem framing stress that it results from the active processing of information, knowledge and cues (Baer et al., 2013; Mumford et al., 1994). Following this view, our study focuses on these conscious processes of creative thought. In this sense, the creative process involves processing modalities—that is, creative logics (Gilhooly, 2016; Runco, 2014)—defined as ways to creatively manipulate and process information, cues, and knowledge (Runco, 2014). Some theoretical accounts suggest the creative logics that may be applied to problem framing (e.g. Mumford et al., 1994; Runco & Chand, 1995), namely, analogical reasoning (e.g. Cornelissen & Werner, 2014; Holyoak & Thagard, 1995), associative thinking (e.g. Allen & Thomas, 2011) and abductive reasoning (Garbuio & Lin, 2021), but without empirically

investigating the way creative logics are enacted by individuals in the problem framing creative process.

Therefore, using an abductive, qualitative analysis that iteratively moves from data to theory (Strauss & Corbin, 1998), we investigate the creative processes behind problem framing to explore our research question: *How do individuals enact creative logics in problem framing?* We collected our primary data through ethnographically observing six design thinking workshops and the natural conversations among 72 workshop participants. We open-coded the data (Strauss & Corbin, 1998) describing how individuals enact creative logics in problem framing to identify seven creative operations enacted in the problem framing creative process.

Our study's contributions are twofold. First, we respond to Posen et al.'s (2018) call for a better understanding of how innovation problems are framed. Specifically, unlike Cornelissen and Werner (2014), we investigate the process of problem framing and not its outcome and the creative operations leading to the outcome. As our second contribution, we present an empirical understanding of the creative logics and lower-level operations in action to gain a theoretical understanding (e.g. Beckman, 2020; Garbuio & Lin, 2021; Gilhooly, 2016). In particular, the seven creative operations we identify provide insights on how individuals enact the creative logics in the problem framing process, and specifically the lower-level operations of three creative logics: associative thinking (Mednick, 1962; Simonton, 2013), analogical reasoning (Holyoak & Thagard, 1995; Islam et al., 2016) and abductive reasoning (Golden-Biddle, 2021; Pribram, 1999—citing Peirce, 1934).

From a managerial standpoint, our study contributes to understanding problem framing and how different creative logics and their underpinning operations can be enacted. Our study also informs managers on individual activities to encourage when facing ill-defined problems, thus raising their metacognition or awareness of their thought processes.

## 2 | THEORETICAL BACKGROUND

When organizations recognize that performance is below aspiration, they look to innovation to discover solutions that reduce the misalignment between the aspired and actual level of performance (Posen et al., 2018). This misalignment between expectation and reality constitutes the problem (Getzels, 1975) presented to individuals. Before solving the problem, a necessary preparatory step (Amabile & Pratt, 2016) is problem framing (Abdulla & Cramond, 2018; Mumford et al., 1994). Solutions should result from a deeper understanding of the problem (Reiter-Palmon & Robinson, 2009). In fact, working on the problem space is pivotal to setting the creative endeavour (Abdulla et al., 2020; Unsworth, 2001), as the firm's decision to innovate is likely a by-product of individuals' problem framing (Gavetti & Levinthal, 2000). As Posen et al. (2018) report in their problematic search theory literature review, avoiding the misalignment between problems and their solutions requires a deeper understanding of how problems are framed.

## 2.1 | The nature of problems and their framing

Prior to investigating how problems are creatively framed, it is important to recall that not all problems have the same nature. Indeed, problems differ depending on their a priori structure (Mumford et al., 1994), thus how well the problem is formulated before the individual frames it (Abdulla et al., 2020). Problems can be well defined or ill-defined (Lyles & Thomas, 1988), open or closed (Unsworth, 2001). According to the problem structure, the individual's approach will change (Landry, 1995): In the case of closed and well-defined problems, the individual is presented with a clear problem to which the solving method and solution are not known to him/her, but are known to others (Getzels, 1975, 1982). Conversely, open and ill-defined problems are subject to inquiry. They require the individual to find or even create the problem (Getzels, 1982; Unsworth, 2001) before being able to solve it. They do not specify any goal or cause and effect that may help with problem solving (Abdulla et al., 2020; Getzels, 1975). Scholars describe real-life problems as ill-defined (e.g. Mumford et al., 1994). As innovation problems today are contextualized in a VUCA (volatile, uncertain, complex and ambiguous) environment (Bennett & Lemoine, 2014; Troise et al., 2022), implying noisy, broadly dispersed and ambiguous information (Dunne & Dougherty, 2016), they are arguably even more ill-defined.

Problem framing means forming mental representations that simplify the problem (Cyert & March, 1963). Through problem framing, individuals frame their interpretation of the problem's goal, the assumptions and the paths towards a solution in a clearer mental representation (Holyoak et al., 1984; Mumford et al., 1994). Studies on problem framing have their roots in the Carnegie line of research (Cyert & March, 1963; March & Simon, 1993), mostly adopting an outcome perspective (Cornelissen & Werner, 2014). Indeed, problem framing is mainly described in terms of two types of outcomes: RF and CF. The first type (RF) implies the use of already established problem representations derived from experience or theoretical knowledge (Dunbar et al., 1996; Gavetti & Levinthal, 2000). In this case, the noisy information is framed within pre-existing problem representations (Benner & Tripsas, 2012) that are familiar to the individual (Kajzer & Walinga, 2017). These problem representations are deeply rooted in pre-existing or available knowledge (Gavetti & Levinthal, 2000). RF describes the almost automatic application of expectancies (Dijksterhuis & Nordgren, 2006; Reiter-Palmon & Illies, 2004) whereby in the noise of the information, the individual recognizes and applies an available problem representation.

The second type of problem framing outcome (CF) implies a change in the established problem representations by constructing new or transforming existing representation (Cornelissen & Werner, 2014; Silk et al., 2021). CF stresses the manipulation and generation of new representations to accommodate the new and ill-defined information (Vandenbosch & Higgins, 1996).

Since the nature of today's ill-defined problems implies high levels of ambiguity and uncertainty, studies suggest that framing ill-defined problems in innovation requires a creative process (Harvey &

Kou, 2013; Mumford et al., 1994), albeit providing limited insights on how this process unfolds.

## 2.2 | The creative logics in problem framing

To clarify the creative processes behind problem frames, we look to the 'process' definition of creativity (Hennessey & Amabile, 2010; Runco, 2004). In particular, creativity defines the thought processes that lead individuals towards original and adaptive ideas, solutions or insights (Runco, 2014), hence creative thinking (Rhodes, 1961). The creative process underlying the elaboration and active processing of information, knowledge and cues linked to ill-defined problems (Mumford et al., 1994) involves processing modalities—that is, creative logics (Gilhooly, 2016; Runco, 2014; Runco & Chand, 1995). Creative logics are thinking modalities that individuals adopt to go beyond the information provided and manipulate knowledge (Aggarwal & Woolley, 2019; Runco, 2014). The creative thinking literature has suggested three main creative logics associated with the manipulation of information or knowledge (Abdulla et al., 2020; Runco, 2014; Runco & Chand, 1995): analogical reasoning (Holyoak et al., 1984), associative thinking (Mednick, 1962) and abductive reasoning (Peirce, 1934).

### 2.2.1 | Analogical reasoning

Among these creative logics, analogical reasoning has a more explicit link with problem framing according to the literature (Cornelissen & Werner, 2014; Gavetti, 2005). Analogical reasoning is potentially linked to a change in problem framing, as it provides new inferences and insights. It is a creative logic that supports knowledge and information processing (Moreno et al., 2014) coherent with the figure of speech analogy that describes the comparison and correlation between two dissimilar things that share a connection at a deeper or more abstract level. Hence, analogical reasoning can be defined as a way of thinking in which the individual finds parallelisms among different knowledge and information (Holyoak & Thagard, 1995). In particular, analogical reasoning unfolds as the knowledge from one input—the source—is transposed and applied to another—the target (Cornelissen, 2006; Goucher-Lambert et al., 2019). This is enabled by identifying a connection or relationship between the source and the target (Chan et al., 2015; Holyoak & Thagard, 1995; Tseng et al., 2008). The processing of available knowledge and information through analogical reasoning entails mapping and seeding the analogical relations between the information and available knowledge and then retrieving useful concepts that applied well to the source can help in understanding the target (Goucher-Lambert & Cagan, 2019).

### 2.2.2 | Associative thinking

Conceptual reviews of creative thinking in psychology have linked associative thinking with creative thinking (Runco, 2004, 2014;

Runco & Chand, 1995). Associative thinking was first introduced by Mednick (1962) to explain the generation of novel and useful ideas as dependent on the ability to 'bring otherwise mutually remote ideas into contiguity' (p. 222). It describes the conscious or unconscious exposition, search and recombination of knowledge and information (Simonton, 1999, 2013). Differently from the creative logic that searches for useful concepts of a source and their purposeful application to a target (Goucher-Lambert & Cagan, 2019), associative thinking does not necessarily entail parallelism between the information and knowledge put into contiguity (Runco, 2014). In fact, associative thinking consists of creating and finding links among distant information and knowledge that are not at all linked (Runco, 2014). Associative thinking allows individuals to retrieve distant knowledge and information (Ward & Kolomyts, 2010) through engaging in associations of elements through serendipity, similarity and mediation (Mednick, 1962). Indeed, serendipity allows individuals to generate novel and meaningful variants of solutions by actively searching for accidental contiguities of distant elements (Mednick, 1962). In this logic, individuals search for inputs as they randomly converge memories, everyday observations, emotions, past experiences and existing knowledge (Campbell, 1960). Then, through a Darwinian process, just a few inputs emerge (Simonton, 1999). Similarity instead describes the connection of inputs that appear remote but share similarities (Mednick, 1962), for example, two products sharing the same underlying function as they cover the same need. Finally, mediation describes the search of inputs using a mediatory concept that links two very remote elements (Mednick, 1962). Associative thinking is highly recognized in the creative psychology community and is the basis of the well-known remote associates test (RAT) used to determine a human's creative potential (Wu et al., 2020). Nonetheless, this creative logic has not yet been investigated in the managerial domain.

### 2.2.3 | Abductive reasoning

Officially introduced by Peirce (1934), abductive reasoning describes a logic that responds to unexpected cues that instil doubt and surprise, as they shake one's beliefs (Golden-Biddle, 2021). It is at the root of any creative inspiration that aims to create new knowledge through the formation of explanatory hypotheses that propose speculative but plausible explanations with the aim of reconciling the differences between different knowledge and information (Folger & Stein, 2017). Indeed, abductive reasoning is a creative logic in which individuals find hypothetical leaps (Dew, 2007). As Thagard and Shelley (1997) state, individuals form and evaluate hypotheses to make sense of puzzling facts (Golden-Biddle, 2021). In particular, this logic requires imagining 'what might be' (Dong et al., 2016; Kolko, 2015). In this sense, abductive reasoning describes the motivated and continuous effort to understand connections between different information and knowledge inputs to anticipate their trajectories and act effectively. Hence, it is the appropriate creative logic for making sense of new or unknown combinations to deal with uncertainty (Richardson & Kramer, 2006). In their study, Dunne and Dougherty (2016) argue that

the abductive reasoning literature is mostly conceptual, calling for more empirical work on this type of reasoning and how people use it.

This brief literature review shows that despite the importance of creative logics, little empirical research has investigated these logics 'in action', and even less so in problem framing. Although some scholars address the potential link between analogical reasoning and CF (Cornelissen, 2006; Gavetti et al., 2005), the creative thinking literature suggests two other creative logics with transformational power (Mumford et al., 1994), namely, associative thinking (Mednick, 1962) and abductive reasoning (Peirce, cited by Pribram, 1999). Nevertheless, scholars have mainly investigated these two creative logics in relation to the generation of solutions rather than framing the problem. Hence, there is a need to understand how individuals apply these logics to process and manipulate information into different problem representations. As such, we aim to open the black box of problem framing by understanding the way individuals use creative logics in framing ill-defined problems.

## 3 | METHODS

The objective of this study is to empirically understand the creative logics in problem framing through the contextualized ethnographic observation of individuals engaging in a problem framing exercise (Van Maanen, 2011). Inspired by Giudici et al. (2018), the setting of our ethnographic observation is a major annual initiative of multiple events organized by the Italian Design Thinking community. Specifically, we collected the data at three main events hosting six innovation workshops focused on the problem framing topic. We conducted an abductive, qualitative analysis to explore how individuals use these forms of reasoning in problem framing. In line with Dunne and Dougherty's (2016) study on how groups use abductive reasoning in drug discovery, and coherently with Strauss (1987), our analysis iteratively moved from data to theory, and vice versa.

### 3.1 | Research setting

Design thinking is a problem-solving method that leverages creative thinking to foster innovation (Dell'Era et al., 2020). One of the core themes of design thinking is problem framing (Carlgren, Rauth, & Elmquist, 2016; Magistretti, Bianchi, et al., 2021; Micheli et al., 2019). In their study, Carlgren, Elmquist, and Rauth (2016) demonstrate that design thinkers work on the problem, iteratively reformulating the initial problem before moving on to their solving efforts. The reason behind the tendency to creatively work on problem framing (Christiaans, 2002; Micheli et al., 2019) lies in the nature of design thinking challenges. Design thinking entails working with ambiguity (Stigliani & Ravasi, 2012), as it is normally associated with 'wicked problems' (Buchanan, 1992; Rittel & Webber, 1973). We consider wicked problems as synonymous with ill-defined problems (Dillon, 1982), since they have neither a definitive formulation nor a right solution (Dorst, 2011). Moreover, Bleda et al. (2021) point out

that design thinking innovation encompasses a set of mental structures and strategies to deal with creative problem framing and solving.

With this in mind, we searched for a setting that would allow us to identify our research sample, hence selecting the annual initiative organized by the Italian Design Thinking community. Each year, it organizes events that gather design thinkers from different settings. The community is composed of design thinkers from design agencies, national design or innovation units of international consultancies and design or innovation units of firms operating in different sectors (e.g. financial services, telco, utilities, pharma, etc.). We selected three events that we attended as silent participants. These events followed a specific format wherein two companies (design agency and consultancy) organize and design the workshops. During the workshops, we were able to observe six sessions. Each workshop asked participants to define a direction for an open challenge or present a specific innovation challenge in line with the event topic. Two focused on changes in the retail industry (packaging-free retail), two on public mobility (car sharing or public transport), and two on the evolution of the work environment during COVID-19. The individuals participating in the workshop were very heterogeneous both in terms of background and experience in the field. Their expertise spanned from design to development to business, and their experience varied from junior to c-level positions. This allowed reducing potential bias deriving from a unique perspective of the problem framing process.

### 3.2 | Data collection

We collected the data by ethnographically observing 72 individuals participating in the six innovation workshops (Table 1), allowing us to systematically observe the way the creative logics were enacted without discerning the situational conditions (LeCompte & Schensul, 2010; Locke, 2011; Woodman & Schoenfeldt, 1990). Due to COVID-19 restrictions, the workshops were held online. Along with four supporting ethnographers, we attended the workshops as silent observers and recorded each session lasting around 3 h. During each session, we took field notes of any behaviours, actions or words that could explain the use of creative logics with the help of two templates (Figure 1) to gather (i) contextual information and (ii) the actions of individuals and inputs they received, hence observing their creative logics throughout the creative workshop tasks.

Participants were guided by a facilitator through the individual and group activities. During group activities, participants initially took turns to share their individual activity output. In this sharing session, participants explained not only their idea but also how they had arrived at it. A group discussion followed each sharing moment. During the discussion, participants worked together to complete the activity while reasoning with others. Coherent with the think-aloud studies of Gestalt psychologist Duncker (1945), we considered individual sharing as a retrospective verbalization of the thought process. Similarly, we considered the conversational moments as ‘an authentic verbal output of real-time thinking’ (Goldschmidt, 2014, p. 29). The recording of both the retrospective and real-time verbalization of

**TABLE 1** Data collection

Data type	Data collected	Purpose of data collected
<i>Primary</i>	<ul style="list-style-type: none"> <li>6 ethnographic observations of 6 workshops, each composed of the completed templates and the transcripts of conversations for a total 47 pages</li> <li>Video recordings of around 3 h (1.5–2 h of effective conversations) for each workshop for a total of over 10 h</li> </ul>	<ul style="list-style-type: none"> <li>Retrospective verbalization of the thought process (and creative logics) in problem framing</li> <li>Real-time verbalization of the thought process (and creative logics) in problem framing</li> <li>Nuances of interactions between the individual and the environment or inputs to support the reconstruction of the individual's thought process</li> </ul>
<i>Secondary</i>	<ul style="list-style-type: none"> <li>Information on the experience and expertise of the 72 participants through online research</li> <li>Facilitators' material to guide participants</li> </ul>	<ul style="list-style-type: none"> <li>Identify the individual antecedents constituting the pre-existing knowledge base of participants</li> <li>Understand the type of challenge (initial problem structure and facilitator's input) and output expected from participants (facilitator's guide)</li> <li>Understand the type of inputs provided to participants</li> </ul>
<i>Material artefacts</i>	<ul style="list-style-type: none"> <li>6 Miro boards with the output of each team analysed consisting of the templates used and compiled by participants, post-it notes and images, for a total 42 pdf pages</li> </ul>	<ul style="list-style-type: none"> <li>Analyse all the information and find relevant patterns and data</li> <li>Software to map the creative innovation process, pdfs to follow the overall process and integrate the recordings with concrete outputs</li> </ul>

thoughts served as our primary data source supported by the written outputs of the activities (i.e. compiled templates and post-it notes).

A secondary data source consisted of archival documentation from the facilitating companies, namely, the workshop brief, the context of the workshop challenge and the process followed during the workshop. Another secondary data source comprised background

**FIGURE 1** Data collection templates [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/cam.12543)]

information on the participants and the material they produced. These secondary sources aimed at contextualizing the individuals and understanding their role, expertise and experiences.

### 3.3 | Data analysis

In the data analysis, we followed an iterative process combining protocol analysis practices (Ericsson & Simon, 1980) using Strauss and Corbin's (1998) cyclical movement from data to theory, and vice versa. The combination of the two methodologies helped us articulate preliminary hypotheses on the themes resulting from the combination of deductive and interpretative thematic analysis (Clarke et al., 2015), allowing us to code the data as shown in Figures 2 and 3. We next outline the process in four steps.

#### 3.3.1 | Step 1: Defining the preliminary hypotheses and rules

First, we transcribed all the recorded the participants' conversations and then combined them with the field notes collected during the workshops and the material used and produced. Our objective was to understand how they used the creative logics in problem framing. For this reason, we took a positivist stance by defining high-level and preliminary hypotheses to investigate the empirical data (Gephart, 2004). We first hypothesized that creative logics are somehow involved in problem framing. As the right template in Figure 1 shows, our hypotheses on the specific creative logics changed over time. Indeed, we iteratively reframed and refined them in a cyclical movement from data to theory and from theory to data. As we defined our hypotheses on the creative logics mostly connected with problem framing, we used their theoretical definitions as 'rules' for the association of our findings and hypotheses (Gephart, 2004). This helped us track the creative actions and behaviours related to the creative logics in each workshop.

#### 3.3.2 | Step 2: Coding through making thoughts explicit

At the end of each workshop, all researchers shared their initial thoughts and observations. Then, we either read or re-watched the recorded workshop sessions to familiarize ourselves with the workshop flow. After reading and triangulating the data (Strauss & Corbin, 1998), the lead author open-coded the statements describing the creative activities enacted by individuals. Given the nature of the data resulting from the think-aloud method (Goldschmidt, 2014), we constructed the codes by reverse engineering the statements to allow making the underlying thought process explicit. This was enabled by triangulating all the available data (Figure 2). The coding was performed through six iterations and cross-checked with the other authors, an iterative process that culminated in the elimination of redundancies and the convergence of codes into first-order categories (Figure 3).

With the aim of clarifying our coding criteria, we present Michele's statement:

For example, looking at a culture that I know, such as the Asian, Japanese put hygiene above the problem of sustainability. In this moment, the pyramid of needs has changed a little: the hygiene problem seems to be above the sustainability one.

We coded this statement 'affinity with a culture or service'. Michele was working on future retail challenges. This workshop was organized during lockdown (when COVID-19 had just hit Italy), and the challenge asked participants to provide a future direction for a packaging-free store. As the group discussed the conflict between sustainability and health, Michele presented the Japanese culture as an inspiration to support the importance of working on the health problem. Therefore, he first found a parallel between the sustainability versus health debate and the Japanese culture using the latter to contribute to the debate (further examples are available in the Appendix).

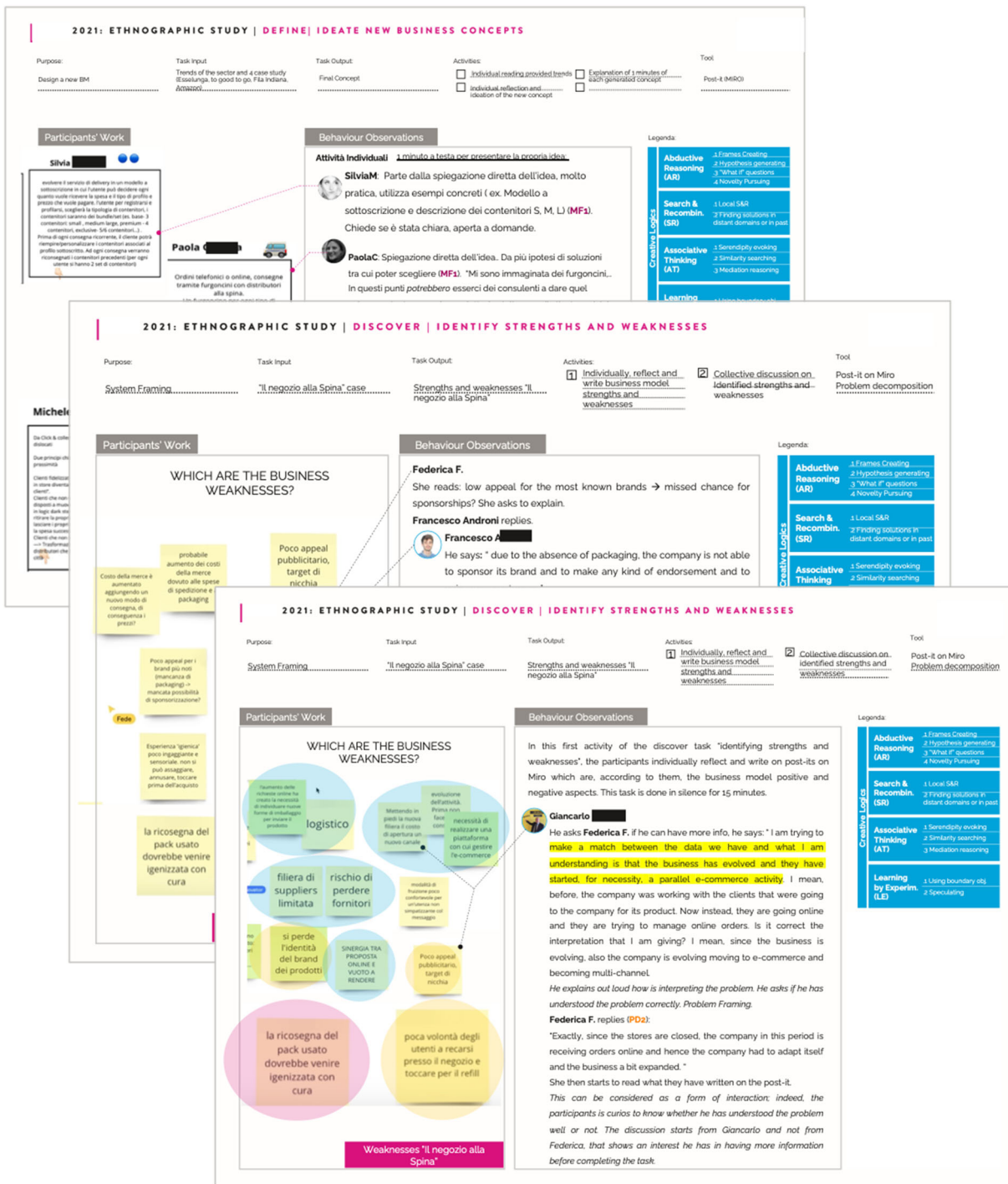
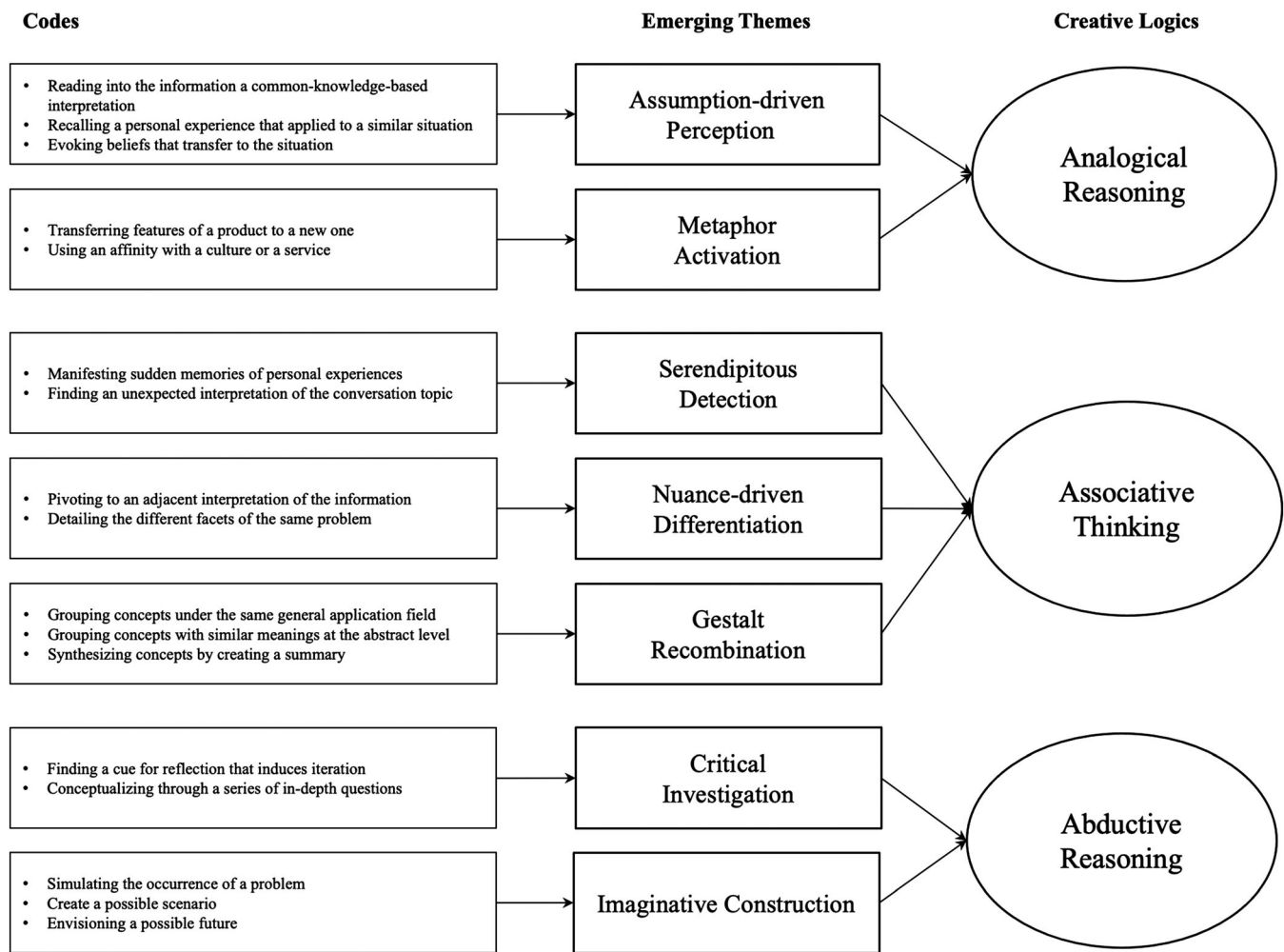


FIGURE 2 Field notes and material artefacts [Colour figure can be viewed at wileyonlinelibrary.com]

### 3.3.3 | Step 3: Tracing the creative logics of individuals

In the third step, we shifted from describing and reconstructing the creative activities to formulating meaningful interpretations to foster knowledge of the creative logics. We assembled the codes into more abstract themes by constantly comparing the codes and searching for patterns in the 21 sets. Specifically, we constructed the themes

following an interpretative and partially deductive thematic analysis (Clarke et al., 2015). In so doing, we identified seven themes that represented the creative operations performed by individuals to enact the creative logics in problem framing (Figure 3). Some examples are 'simulating the occurrence of a problem', 'creating a possible scenario' and 'envisioning a possible future'. These are all similar, as they describe how individuals create something different from the present 'here and now' from their imaginative construction. In turn, the



**FIGURE 3** Coding the creative logics

imaginative construction can be linked with the imaginative nature of abductive reasoning building a whole to explain surprising cues (Dunne & Dougherty, 2016).

### 3.3.4 | Step 4: Finding problem representations of creative operations

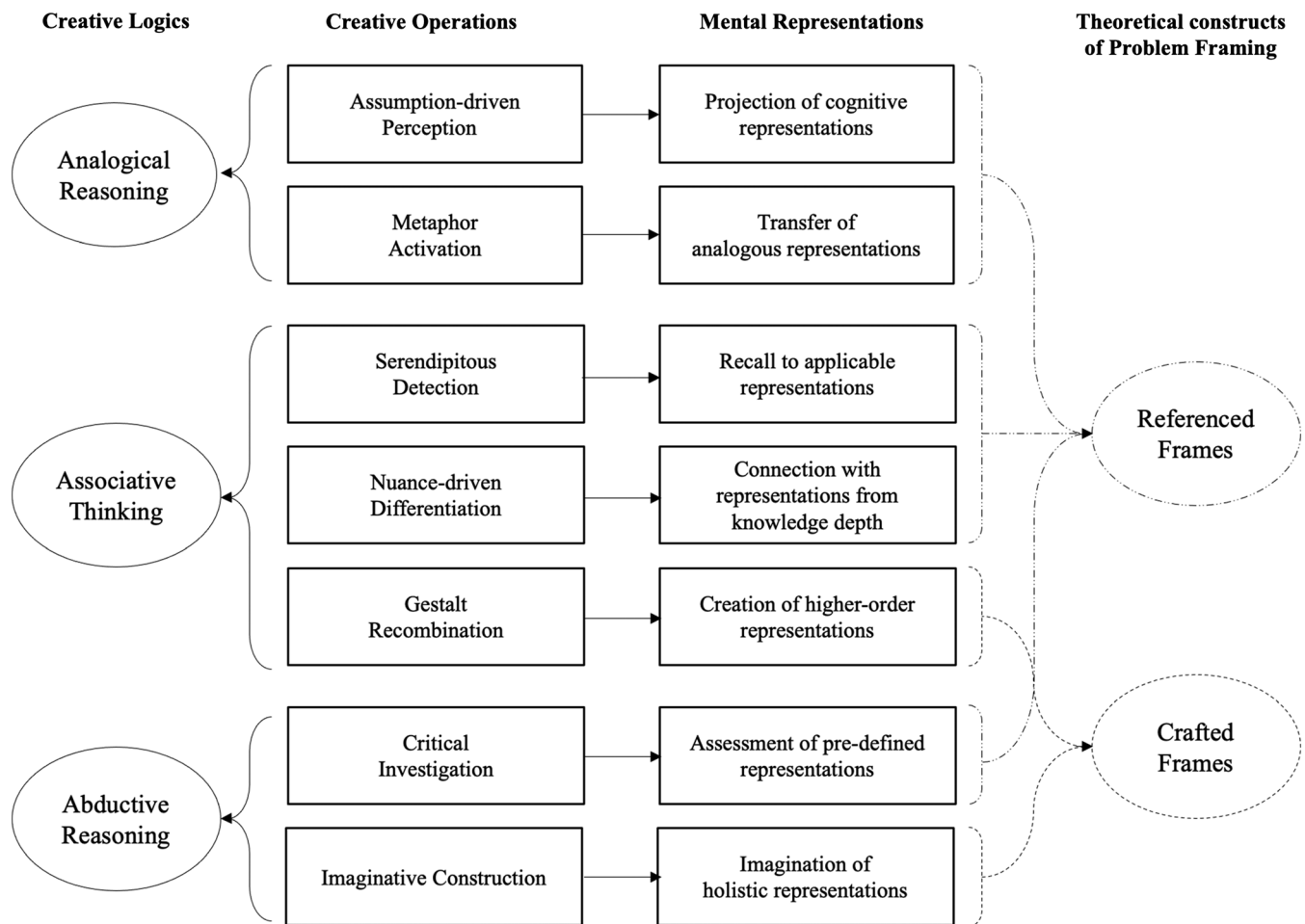
The identification of the creative operations underlying the enactment of the creative logics was followed by a final step inspired by Stigliani and Ravasi (2012) who ‘associated material practices to sub-cognitive processes’. Similarly, we associated the creative operations with the respective mental representations produced (Figure 4), which we carefully analysed and labelled according to the interpretative thematic analysis (Clarke et al., 2015). The labels describe the mental representation that individuals used. We labelled the resulting mental representations with expressions alluding to the result of an action performed on the object ‘representation’ (e.g. ‘projection of cognitive representations’, ‘assessment of pre-defined representations’).

As in the creative logics case, our analysis showed that we could categorize the mental representations produced in the two theoretical constructs into Cornelissen and Werner’s (2014) RF and CF. Hence, we were able to characterize the application of each creative logic—creative operation—with the two forms of problem framing outcomes produced (Figure 4).

## 4 | FINDINGS

The observation of participants and their creative thought processes over the six workshops allowed identifying seven creative operations they performed to apply the creative logics of analogical reasoning, associative thinking and abductive reasoning in the problem framing process. In particular, we found that participants applied analogical reasoning through the *assumption-driven perception* and *metaphor activation* creative operations, performing both to search for available mental representations that could be applied to interpret the ill-defined problem. Instead, when participants applied associative





**FIGURE 4** Associating the creative operations with the respective mental representations

thinking, they made recourse to the *serendipitous detection*, *nuance-driven differentiation* and *gestalt recombination* creative operations, the first two to retrieve the available mental representations and the last to create a new mental representation by combining multiple elements. Finally, when participants applied the creative logic of abductive reasoning, they performed the *critical investigation* creative operation to assess the available representations that could frame the ill-defined problem and *imaginative construction* to build new mental representations. We next present the creative operations and how the participants applied the creative logics (additional data available in the Appendix).

#### 4.1 | Assumption-driven perception as the application of analogical reasoning

The first creative operation refers to the *assumption-driven perception*. In the workshops, participants who adopted this creative operation used their knowledge system as a source to formulate assumptions. Indeed, they searched for analogical parallelisms between the target information and what they knew from past experience, general knowledge or their beliefs. In the case of assumption-driven perception,

individuals selectively perceive only the information that confirms their initial assumption. Specifically, they assume that a mental representation compliant with conventional wisdom can be applied to the problem: individuals read into the information what they assume to be ‘generally’ true. For example:

So, by reading its description, *Negozio alla Spina* takes pride in being a packaging-free store. Certainly, I assume the customers that usually go there are also sensitive to the theme of sustainability. So, we should rethink distribution during COVID in a way that is sustainable, for instance, no underpaid riders. (Gabriele)

In his case, Gabriele interpreted the problem of *Negozio alla Spina* within the reference frame of sustainability. He transferred user needs for sustainable consumption to *Negozio alla Spina*, automatically perceiving ‘packaging-free’ as synonymous with sustainability. Hence, he assumed that the store’s customers were sensitive to sustainability. Of course, this may not be true, as they might also have different motivations (e.g. other participants highlighted the possibility of choosing the store for its higher quality rather than its sustainability).

Similarly, the assumptions also drew on personal life experiences. Indeed, some participants recalled mental representations from past experiences, finding parallels with the information provided in the brief. They assumed the existence of an analogy between their experience and the experience implied in the ill-defined problem. This is the case of Luciano who applied his personal experience as a resident of Milan to frame the ill-defined problem of shared mobility:

Well, especially in Milan—but I assume also in other cities—people use car sharing according to where they live. I think this is big pain point: the map range and availability ... we need more of it! Of course, I'm just assuming things, we should also see what the data says. (Luciano)

Alternatively, assumptions were also generated from personal beliefs, as some participants projected their own beliefs onto the information described in the brief, ultimately helping them find an available mental representation for the problem. Maria's example shows the projection of consolidated personal beliefs. While discussing public transport services in Milan, she projected her consolidated belief about the effects of the pandemic (change in where and how people will live), thus implicitly applying it to the public transport problem.

The pandemic pushed people to rethink and change the way they live. I think that people don't want to live in the (city) center anymore. (Maria)

In terms of the produced problem representations, a common thread is the top-down application of mental representations stemming from cognition, namely, actively retrieving conventional wisdom, past experiences or beliefs (see Appendix, Table A1).

## 4.2 | Metaphor activation as the application of analogical reasoning

Over the six workshops, participants used metaphors—that is, a rhetorical figure of speech that correlates two elements—to draw problem representations from inspiring cases. By mapping the parallels between their target problem and an inspiring source, they applied the source's problem representations to interpret and understand the target's ill-defined problem. In adopting *metaphor activation*, participants identified parallels between the information in their brief and the features of another product, service or culture. In so doing, they retrieved the problem representations of the parallel product, service or culture and applied them to the brief in a plug-and-play manner. In the case of Chiara, she found a parallel between food delivery (ill-defined target problem) and Amazon (source of inspiration). She framed the food delivery problem with the mental representation of Amazon that had already identified and solved a parallel problem—that is, how to deliver items when people are not at home:

For example, we should think about where to leave the food for delivery. Maybe some secure storage points, with a dedicated space for customers. Like Amazon lockers: this is interesting if we refer to the theme of the conversion of empty spaces. (Chiara)

Participants who performed metaphor activation framed the ill-defined problem by finding affinity with a different culture or service, thus transferring what they knew about that culture or service to interpret the information in the brief. For example:

I believe there are different degrees of being packaging free. For instance, every supermarket in Germany has returnable packaging. Items are not really packaging free, if you think about it. But they are cutting down the impact of packaging! You return the packaging to the shop and they give you money in return. You know, Italy used to have the same system. So the question here is: why does it work in Germany and not in Italy? (Francesca)

In these cases, the common thread among the mental representations of metaphor activation is the top-down application of analogous representations from parallel case studies or cultures (see Appendix, Table A1).

## 4.3 | Serendipitous detection as the application of associative thinking

Through serendipity, some workshop participants found unforeseen associations within the noise of the ill-defined problem. Indeed, *serendipitous detection* describes the operation an individual performs when making unexpected associations with the problem, thus recalling another possible interpretation of the information. It can activate from variations in the mind and manifests as a sudden association with an unrelated memory, hence recalling an applicable mental representation retrieved from deeper memories. In so doing, individuals find associations between the information and their knowledge. An example is Marzia, who found a seemingly unrelated association between safety (in terms of health) and personal security:

I know that we are talking about health safety, but I was thinking 'what about personal security?': I am a woman and I live alone in Bologna. A car sharing system gives you security: not having to take public transport with sketchy people would make me feel safer. (Marzia)

Although the team discussed a different form of self-protection (health safety), Marzia introduced an associated mental representation. She seemed to be able to see only her own need (i.e. personal security because it is scary to be alone on public transport when you are a woman).

Moreover, serendipitous detection manifested when the conversation topic unexpectedly resurfaced an old mental representation that could be applied to framing the problem. This occurred when the participant linked the group conversation to something unrelated to the topic under discussion. In this case, the association allowed recalling the memory of another available mental representation (see Appendix, Table A2).

#### 4.4 | Nuance-driven differentiation as the application of associative thinking

*Nuance-driven differentiation* describes when individuals identify the hidden dissimilarities or nuances within the analysed information. In a top-down manner, they look for a set of dissimilar interpretations informed by a person's deep knowledge of the topic (see Appendix, Table A2). Instead of using associative thinking to find similarities, individuals who adopt this creative operation use associative thinking to find dissimilarities. The identification of differences instead of similarities can be achieved by pivoting to an adjacent problem, entailing a deep understanding of the core characteristics of a problem to find variants thereof.

Denis provides an example of framing the problem of the intrusiveness of artificial intelligence, but not in terms of finding a way to prohibit it. He applied an adjacent mental representation that he believed was more fitting—that is, finding ways to educate it.

Ok, AI has gone bad. It listens to our conversations, even when not explicitly requested, and more. However, instead of thinking of ways to prohibit something (AI) that already exists today and is not going in the right direction, the way I see it, we should think of ways to educate its mechanics. (Denis)

Another way individuals can reason through differences is by detailing the different facets of the same problem. Also in this case, they leverage their profound knowledge to retrieve dissimilar mental representations that help differentiate the facets of the same problem.

#### 4.5 | Gestalt recombination as the application of associative thinking

*Gestalt recombination* is the creative operation that leverages higher-order similarities between new information, old knowledge or experiences and other forms of inspiration to explain how they combine and create interesting and new problem representations. Individuals create a Gestalt recombination when connecting different pieces of information or different interpretations through their common tie to an overarching concrete and descriptive feature, such as a common field of application (in the example below, the world of logistics):

We could connect the increase in online requests with the packaging-free theme. Both are linked with logistics. Perhaps we could look at it from the perspective of a need to identify new forms of packaging styles to deliver the product. (Federica)

With the connection of the different pieces of information (i.e. increased online requests and packaging-free), Federica created a combination of mental representations, thus generating a new one (i.e. the need for a new form of packaging for delivery).

Another way individuals use associative thinking through Gestalt recombination is when they create a conceptual interpretation that implies associations at the abstract level, thus synonyms at the level of meaning. For example, Maria created an umbrella representation encompassing the mental representations of other team members to create a mental representation that unifies them all (i.e. decrease in the use of public transport):

If we look at them [indicating the brainstorming post-it notes: 'lack of trust on hygiene standards', 'avoid public places', 'increased need for organization'] from the high level, an aspect that we all mapped is the fact that there is a decrease in the use of public transport, so in my opinion this is the starting point. (Maria)

Finally, this creative operation also manifests when individuals frame the problem with a mental representation that synthesizes the concepts into an overarching summary (see Appendix, Table A2). It stems from a deep (and higher-order) understanding of the information and the personal reinterpretation of the overall picture.

On the one hand, we have the theme of guidance, and on the other hand, the theme of inspiration, both show the deeper need for having someone or something that takes care of your inner self. And this could mean tapping into issues of mental health or mental wellbeing. (Chiara)

#### 4.6 | Critical investigation as the application of abductive reasoning

*Critical investigation* is a creative operation pursued by individuals with an inquisitive nature. Through constant questioning or provocations for iteration, they try to collect as many cues as possible that can support or refute an implicit hypothesis—that is, a pre-existing mental representation. The investigation is highly focalized, as it searches for cues related to the mental representation that the individual is hypothesizing, delving into details to strengthen the initial hypothesis (see Appendix, Table A3). This creative operation emerges from induced iteration as individuals find cues for reflection. Indeed, participants formulated and asked provoking questions to challenge their initial mental representation.

An example is Federica who asked numerous rhetorical questions, implying she has a clear mental representation in mind (i.e. home delivery systems have hidden complications) that needs to be either supported or refuted:

Have you thought about the number of stores in Milan that have started home deliveries? How are they managing it? I think there could be some hidden complications, like there could be new costs associated with the delivery—do you know something about it? (Federica)

Critical investigation can also be achieved when individuals break their thoughts down into smaller more manageable parts. To do so, they momentarily focus on dealing in-depth with one question at a time. Indeed, they reason by engaging in a creative discussion where questions are increasingly detailed and aimed at finding robust confirmation of the initial hypothesis of the mental representation:

To fight Covid consequences, I would consider the problem of widening the range of users to areas not covered. What do you think? (Luca)

#### 4.7 | Imaginative construction as the application of abductive reasoning

*Imaginative construction* describes when individuals construct the whole world to help make sense of surprising and contradicting cues. They use their imagination to foresee the possible occurrence of a future problem, build a context or scenario or imagine a future change. Indeed, the workshop participants often made sense of new information by constructing a mental representation describing a whole simulated reality and the plausible problem. For example, Francesco constructed a mental representation that depicts an entire scenario in which specific people (i.e. *Negozio alla Spina* customers) have specific lifestyles (i.e. hectic lives) that bring about specific problems (i.e. no time for grocery shopping). He started from a simple cue (customers are families and young people) and built a whole scenario as a mental representation.

Thinking about our customers (families and young people), I imagine they are workers with hectic lives, with little time to waste, and if they do have some free time, they want to spend it in a quality way, with their friends and family. In this scenario they don't go to the shops, so they need a weekly solution for their groceries. (Francesco)

Participants also pictured specific use cases. The construction of use cases helped them create a connection among the different building blocks of knowledge and information. Indeed, some adopted abductive reasoning and imagination to create concrete yet hypothetical use cases that helped them make sense of the information and

construct a new mental representation. For instance, Claudio built a detailed use case (i.e. a user's commute to an event) that helped him make sense of the public transport problem in Milan and allowed him to build a mental representation around the journey's organization and destination time:

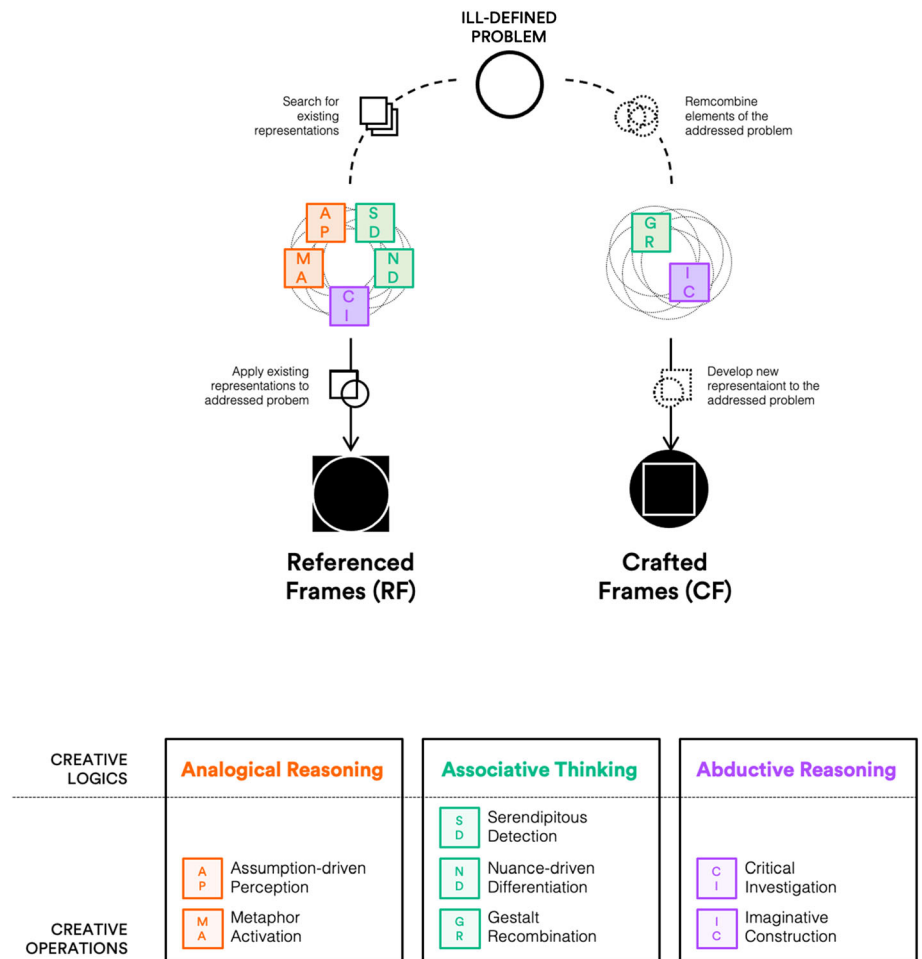
(I imagine that ...) When the user needs to go to an event, he puts the destination in the ATM (public transport) app: the trigger is the place to reach. So, he has to decide which transportation mode he prefers. He chooses the car to the closest metro station and then the metro. As he is reaching the metro station, he receives a message: "continue by car." Maybe the problem could have something to do with the address and—more importantly—the time at which the user wants to arrive. (Claudio)

## 5 | DISCUSSION

The results of our investigation highlight the importance of not jumping directly into the solution but framing the problem (Abdulla Alabbasi et al., 2021; Chen et al., 2016). Our investigation adds to the debate in the innovation management literature on dealing with complex problems (Magistretti, Ardito, & Messeni Petruzzelli, 2021; Pedersen et al., 2022). Past studies argue that problems must be framed to obtain a holistic perspective (Carlgren, Rauth, & Elmquist, 2016; Dell'Era et al., 2020; Magistretti, Ardito, & Messeni Petruzzelli, 2021), yet without providing a clear direction for how to do so, in other words, the process itself and the specific operations to perform. Our study contributes to this literature in two ways. First, we complement the outcome perspective of problem framing (Cornelissen & Werner, 2014; Jablokow, 2008; Kajzer & Walinga, 2017) with a preliminary understanding of the creative logics and operations underlying the creative process. Second, we add to the mostly theoretical or artificial (i.e. non-realistic problems) understanding of creative logics (e.g. Beckman, 2020; Garbuio & Lin, 2021; Gilhooly, 2016) with empirical insights on creative logics in action during problem framing.

Although scholars have studied problem framing as a black box (Langley et al., 2013) with two possible outcomes—RF or CF (Cornelissen & Werner, 2014; Jablokow, 2008; Kajzer & Walinga, 2017)—we provide insights on the creative operations leading to either RF or CF (Figure 5): (i) assumption-driven perception, (ii) metaphor activation, (iii) serendipitous detection, (iv) nuance-driven differentiation, (v) gestalt recombination, (vi) critical investigation and (vii) imaginative construction. These seven creative operations suggest the way creative logics can be used in the problem framing creative process. Coherently with the theory that individuals tend to first apply readily available mental representations (Liu & Maas, 2021), interpreting ill-defined problems with pre-existing expectations and paradigms (Dijksterhuis & Nordgren, 2006; Silk et al., 2021), we find that the creative operations more frequently led to RF. Indeed, five of the seven

**FIGURE 5** Model of creative logics in action in problem framing [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



creative operations were adopted to produce mental representations of the RF type (assumption-driven perception, metaphor activation, serendipitous detection, nuance-driven differentiation and critical investigation). When participants adopted the assumption-driven perception, they retrieved pre-existing mental representations from common wisdom, past experience or consolidated beliefs to frame the problem. Similarly, participants adopted metaphor activation to transfer pre-existing representations from a source to the target. With serendipitous detection, participants remembered an applicable yet pre-existing mental representation. We observed that they forced their pre-existing mental representations onto the problem to find an array of interpretations with nuanced differentiation. Finally, participants engaged in critical investigation to assess a mental representation they already had in mind—likely informed by past experiences or consolidated knowledge—with additional questioning and iteration.

In their study on abductive reasoning in discovery, Dunne and Dougherty (2016) call for more empirical studies on how individuals enact creative forms of reasoning—for example, abductive reasoning, analogical reasoning and associative thinking—in real life settings. Therefore, our research contributes to the creative logics and creative thinking literature (Runco, 2014) with an in-depth exploration of the way individuals enact the creative logics in problem framing. The seven creative operations provide new insights on the cognitive

actions individuals undertake to engage in abductive reasoning, associative thinking, and analogical reasoning in problem framing. The findings suggest individuals use analogical reasoning through *assumption-driven perception* and *metaphor activation* (Gavetti et al., 2005) to map parallels between a source (e.g. past experiences, cases or cultures) and the target problem (i.e. ill-defined) to apply existing mental representations. We observed that participants used associative thinking through *serendipitous detection* and *nuance-driven differentiation* not only to find highly remote associations (Acar & van den Ende, 2016) but also to create detail-oriented associations with applicable mental representations. They retrieved mental representations from latent memory and deep knowledge to use them as framing references. Participants used associative thinking as *gestalt recombination* when they created higher-order connections that drove the creation of new mental representations in problem framing. Coherent with the inquisitive nature of abductive reasoning (Harris, 2011), individuals engage in abductive reasoning through critical investigation to assess their existing mental representations with new cues. Abductive reasoning is also known as the ‘what might be’ logic, as it builds a whole to make sense of unexplainable cues (Garbuio & Lin, 2021; Golden-Biddle, 2021). Hence, with imaginative construction, participants applied abductive reasoning as they built mental representations for a whole imaginary and plausible world.

## 6 | CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH AVENUES

This study contributes to the literature on problem framing (Beckman, 2020; Cornelissen & Werner, 2014) and creative thinking (Golden-Biddle, 2021; Islam et al., 2016; Simonton, 2013) by unveiling seven creative operations that support RF or CF.

The seven creative operations suggest ways in which individuals apply the creative logics of associative thinking, analogical reasoning and abductive reasoning to frame ill-defined problems. Specifically, our study suggests that five creative operations may be conducive to RF (assumption-driven perception, metaphor activation, serendipitous detection, nuance-driven differentiation and critical investigation) and two to CF (gestalt recombination, imaginative construction).

### 6.1 | Implications for practice

From a practitioner perspective, our study seeks to reassert the importance of problem framing in innovation to support managers struggling to make sense of problems in a complex world, guiding them in creating problem representations based on referenced or crafted frames. The seven creative operations identified provide managers and innovators with a set of concrete actions they can perform to foster creative problem framing.

Moreover, by stressing the actions at the cognitive level, our study encourages managers to be more aware of their thought processes, thereby improving their metacognitive maturity. Indeed, greater awareness of one's and others' thought processes is fundamental for problem framing, as it improves one's sensitivity to problems (Abdulla Alabbasi et al., 2021; Runco & Chand, 1995). Finally, our study reinforces the idea that creativity can be cultivated (Kelley & Kelley, 2013).

### 6.2 | Limitations

Like all studies, our work has some limitations. First, important to stress is that at the neurological level, the creative process—intended as creative cognition (Rhodes, 1961; Runco, 2004)—is the result of the interaction of two large-scale brain networks: the default network, associated with uncontrolled, spontaneous and internally projected thought (Beaty et al., 2015; Bendetowicz et al., 2018), and the executive network, associated with evaluative and goal-oriented thoughts that are dependent on external inputs (Beaty et al., 2015; Bendetowicz et al., 2018). One could argue that our study of creative logics for problem framing mainly focuses on the executive network since they are processing modalities of creativity that elaborate and evaluate information, cues and knowledge. Nevertheless, some of our creative operations may also be the result of the default network (e.g. serendipitous detection). Hence, future studies adopting a neurological lens could leverage the neurological understanding of the

creative process to investigate problem framing as a result of the uncontrolled and spontaneous generation of thoughts.

Moreover, our study proposes a simplified description of the creative process in problem framing by isolating seven thinking actions in the problem framing creative process—that is, creative operations. Future studies could investigate the dynamic interaction of creative operations by identifying the different combinations of creative logics and related operations.

Concerning the methodological limitations, the qualitative nature of our study constrains the generalizability of our findings beyond this study. Hence, we call for future quantitative studies that further investigate and test our propositions.

The semi-real setting of the three innovation events in Italy cannot exclude cultural or national effects or the observation of creative logics over time. Future studies might therefore address this limitation by investigating the creative operations and logics in real-life settings to verify how individuals embedded in organizational settings leverage different information in problem framing. It would also be valuable to investigate the influence of different nationalities and cultural backgrounds on the effect of these problem framing logics and operations. Finally, future research could also examine problem framing over the timespan of different projects.

### ACKNOWLEDGMENTS

Open Access Funding provided by Politecnico di Milano within the CRUI-CARE Agreement.

### DATA AVAILABILITY STATEMENT

Data available on request from the authors

### ORCID

Cristina Tu Anh Pham  <https://orcid.org/0000-0002-1639-4142>

Stefano Magistretti  <https://orcid.org/0000-0001-9968-7030>

Claudio Dell'Era  <https://orcid.org/0000-0002-4930-2208>

### ENDNOTE

<sup>1</sup> <https://www.youtube.com/watch?v=8Wig7ckbPqU>

### REFERENCES

- Abdulla, A. M., & Cramond, B. (2018). The creative problem finding hierarchy: A suggested model for understanding problem finding. *Creativity*, 5(2), 197–229. <https://doi.org/10.1515/ctra-2018-0019>
- Abdulla, A. M., Paek, S. H., Cramond, B., & Runco, M. A. (2020). Problem finding and creativity: A meta-analytic review. *Psychology of Aesthetics, Creativity, and the Arts*, 14(1), 3–14. <https://doi.org/10.1037/aca0000194>
- Abdulla Alabbasi, A. M., Reiter-Palmon, R., Sultan, Z. M., & Ayoub, A. E. A. (2021). Which divergent thinking index is more associated with problem finding ability? The role of flexibility and task nature. *Frontiers in Psychology*, 12, 671146. <https://doi.org/10.3389/fpsyg.2021.671146>
- Acar, O. A., & van den Ende, J. (2016). Knowledge distance, cognitive-search processes, and creativity: The making of winning solutions in science contests. *Psychological Science*, 27(5), 692–699. <https://doi.org/10.1177/0956797616634665>

- Aggarwal, I., & Woolley, A. W. (2019). Team creativity, cognition, and cognitive style diversity. *Management Science*, 65(4), 1586–1599. <https://doi.org/10.1287/mnsc.2017.3001>
- Allen, A. P., & Thomas, K. E. (2011). A dual process account of creative thinking. *Creativity Research Journal*, 23(2), 109–118. <https://doi.org/10.1080/10400419.2011.571183>
- Amabile, T. M., & Pratt, M. G. (2016). The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning. *Research in Organizational Behavior*, 36, 157–183. <https://doi.org/10.1016/j.riob.2016.10.001>
- Baer, M., Dirks, K. T., & Nickerson, J. A. (2013). Microfoundations of strategic problem formulation. *Strategic Management Journal*, 34, 197–214. <https://doi.org/10.1002/smj.2004>
- Beaty, R. E., Benedek, M., Barry Kaufman, S., & Silvia, P. J. (2015). Default and executive network coupling supports creative idea production. *Scientific Reports*, 5(1), 10964. <https://doi.org/10.1038/srep10964>
- Beckman, S. L. (2020). To frame or reframe: Where might design thinking research go next? *California Management Review*, 62(2), 144–162. <https://doi.org/10.1177/0008125620906620>
- Bendetowicz, D., Urbanski, M., Garcin, B., Foulon, C., Levy, R., Bréchemier, M.-L., Rosso, C., Thiebaut de Schotten, M., & Volle, E. (2018). Two critical brain networks for generation and combination of remote associations. *Brain*, 141(1), 217–233. <https://doi.org/10.1093/brain/awx294>
- Benner, M. J., & Tripsas, M. (2012). The influence of prior industry affiliation on framing in nascent industries: The evolution of digital cameras. *Strategic Management Journal*, 33(3), 277–302. <https://doi.org/10.1002/smj.950>
- Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. *Business Horizons*, 57(3), 311–317. <https://doi.org/10.1016/j.bushor.2014.01.001>
- Berg, J. M. (2019). When silver is gold: Forecasting the potential creativity of initial ideas. *Organizational Behavior and Human Decision Processes*, 154, 96–117. <https://doi.org/10.1016/j.obhdp.2019.08.004>
- Bleda, M., Querbes, A., & Healey, M. (2021). The influence of motivational factors on ongoing product design decisions. *Journal of Business Research*, 129, 562–569. <https://doi.org/10.1016/j.jbusres.2020.02.018>
- Buchanan, R. (1992). Wicked problems thinking in design. *Design Issues*, 8(2), 5–21. <https://doi.org/10.2307/1511637>
- Campbell, D. T. (1960). Blind variation and selective retentions in creative thought as in other knowledge processes. *Psychological Review*, 67(6), 380–400. <https://doi.org/10.1037/h0040373>
- Carlgrén, L., Elmquist, M., & Rauth, I. (2016). The challenges of using design thinking in industry – Experiences from five large firms. *Creativity and Innovation Management*, 25(3), 344–362. <https://doi.org/10.1111/caim.12176>
- Carlgrén, L., Rauth, I., & Elmquist, M. (2016). Framing design thinking: The concept in idea and enactment. *Creativity and Innovation Management*, 25(1), 38–57. <https://doi.org/10.1111/caim.12153>
- Chan, J., Dow, S. P., & Schunn, C. D. (2015). Do the best design ideas (really) come from conceptually distant sources of inspiration? *Design Studies*, 36, 31–58. <https://doi.org/10.1016/j.destud.2014.08.001>
- Chen, B., Hu, W., & Plucker, J. A. (2016). The effect of mood on problem finding in scientific creativity. *The Journal of Creative Behavior*, 50(4), 308–320. <https://doi.org/10.1002/jobc.79>
- Christiaans, H. H. C. M. (2002). Creativity as a design criterion. *Creativity Research Journal*, 14(1), 41–54. [https://doi.org/10.1207/S15326934CRJ1401\\_4](https://doi.org/10.1207/S15326934CRJ1401_4)
- Clarke, V., Braun, V., & Hayfield, N. (2015). Thematic analysis. In J. A. Smith (Ed.), *Qualitative psychology: A practical guide to research methods* (pp. 222–248). SAGE Publications.
- Cornelissen, J. P. (2006). Making sense of theory construction: Metaphor and disciplined imagination. *Organization Studies*, 27(11), 1579–1597. <https://doi.org/10.1177/0170840606068333>
- Cornelissen, J. P., & Werner, M. D. (2014). Putting framing in perspective: A review of framing and frame analysis across the management and organizational literature. *Academy of Management Annals*, 8(1), 181–235. <https://doi.org/10.1080/19416520.2014.875669>
- Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. Prentice Hall/Pearson Education.
- Dell’Era, C., Magistretti, S., Cautela, C., Verganti, R., & Zurlo, F. (2020). Four kinds of design thinking: From ideating to making, engaging, and criticizing. *Creativity and Innovation Management*, 29(2), 324–344. <https://doi.org/10.1111/caim.12353>
- Dew, N. (2007). Abduction: A pre-condition for the intelligent design of strategy. *Journal of Business Strategy*, 28(4), 38–45. <https://doi.org/10.1108/02756660710760935>
- Dijksterhuis, A., & Nordgren, L. F. (2006). A theory of unconscious thought. *Perspectives on Psychological Science*, 1(2), 95–109. <https://doi.org/10.1111/j.1745-6916.2006.00007.x>
- Dillon, J. T. (1982). Problem finding and solving. *The Journal of Creative Behavior*, 16(2), 97–111. <https://doi.org/10.1002/j.2162-6057.1982.tb00326.x>
- Dong, A., Garbuio, M., & Lovallo, D. (2016). Generative sensing: A design perspective on the microfoundations of sensing capabilities. *California Management Review*, 58(4), 97–117. <https://doi.org/10.1525/cm.2016.58.4.97>
- Dorst, K. (2011). The core of “design thinking” and its application. *Design Studies*, 32(6), 521–532. <https://doi.org/10.1016/j.destud.2011.07.006>
- Dunbar, R. L. M., Garud, R., & Raghuram, S. (1996). A frame for deframing in strategic analysis. *Journal of Management Inquiry*, 5(1), 23–34. <https://doi.org/10.1177/105649269651007>
- Duncker, K. (1945). On problem-solving. *Psychological Monographs*, 58(5), i–113. <https://doi.org/10.1037/h0093599>
- Dunne, D. D., & Dougherty, D. (2016). Abductive reasoning: How innovators navigate in the labyrinth of complex product innovation. *Organization Studies*, 37(2), 131–159. <https://doi.org/10.1177/0170840615604501>
- Einstein, A., & Infeld, L. (1938). *The evolution of physics*. Simon & Schuster.
- Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*, 87(3), 215–251. <https://doi.org/10.1037/0033-295X.87.3.215>
- Folger, R., & Stein, C. (2017). Abduction 101: Reasoning processes to aid discovery. *Human Resource Management Review*, 27(2), 306–315. <https://doi.org/10.1016/j.hrmr.2016.08.007>
- Garbuio, M., & Lin, N. (2021). Innovative idea generation in problem finding: Abductive reasoning, cognitive impediments, and the promise of artificial intelligence. *Journal of Product Innovation Management*, 38(6), 701–725. <https://doi.org/10.1111/jpim.12602>
- Gavetti, G. (2005). Cognition and hierarchy: Rethinking the microfoundations of capabilities’ development. *Organization Science*, 16(6), 599–617. <https://doi.org/10.1287/orsc.1050.0140>
- Gavetti, G., Greve, H. R., Levinthal, D. A., & Ocasio, W. (2012). The behavioral theory of the firm: Assessment and prospects. *Academy of Management Annals*, 6(1), 1–40. <https://doi.org/10.5465/19416520.2012.656841>
- Gavetti, G., & Levinthal, D. (2000). Looking forward and looking backward: Cognitive and experiential search. *Administrative Science Quarterly*, 45(1), 113–137. <https://doi.org/10.2307/2666981>
- Gavetti, G., Levinthal, D. A., & Rivkin, J. W. (2005). Strategy making in novel and complex worlds: The power of analogy. *Strategic Management Journal*, 26(8), 691–712. <https://doi.org/10.1002/smj.475>
- Gephart, R. P. (2004). Qualitative research and the academy of management journal. *Academy of Management Journal*, 47(4), 454–462. <https://doi.org/10.5465/amj.2004.14438580>
- Getzels, J. W. (1975). Problem-finding and the inventiveness of solutions. *The Journal of Creative Behavior*, 9(1), 12–18. <https://doi.org/10.1002/j.2162-6057.1975.tb00552.x>

- Getzels, J. W. (1982). The problem of the problem. In R. Hogarth (Ed.), *New directions for methodology of social and behavioral science: Question framing* (pp. 37–49). Jossey-Bass.
- Gilhooly, K. J. (2016). Incubation and intuition in creative problem solving. *Frontiers in Psychology, 7*, 1076. <https://doi.org/10.3389/fpsyg.2016.01076>
- Giudici, A., Reinmoeller, P., & Ravasi, D. (2018). Open-system orchestration as a relational source of sensing capabilities: Evidence from a venture association. *Academy of Management Journal, 61*(4), 1369–1402. <https://doi.org/10.5465/amj.2015.0573>
- Golden-Biddle, K. (2021). Discovery as an abductive mechanism for reorienting habits within organizational change. *Academy of Management Journal, 63*(6), 1951–1975. <https://doi.org/10.5465/AMJ.2017.1411>
- Goldschmidt, G. (2014). *Linkography: Unfolding the design process*. MIT Press. <https://doi.org/10.7551/mitpress/9455.001.0001>
- Goucher-Lambert, K., & Cagan, J. (2019). Crowdsourcing inspiration: Using crowd generated inspirational stimuli to support designer ideation. *Design Studies, 61*, 1–29. <https://doi.org/10.1016/j.destud.2019.01.001>
- Goucher-Lambert, K., Moss, J., & Cagan, J. (2019). A neuroimaging investigation of design ideation with and without inspirational stimuli—Understanding the meaning of near and far stimuli. *Design Studies, 60*, 1–38. <https://doi.org/10.1016/j.destud.2018.07.001>
- Harris, H. (2011). Inquisitiveness and abduction, Charles Peirce and moral imagination. *Business and Professional Ethics Journal, 30*(3), 293–305. <https://doi.org/10.5840/bpej2011303/414>
- Harvey, S., & Kou, C. Y. (2013). Collective engagement in creative tasks: The role of evaluation in the creative process in groups. *Administrative Science Quarterly, 58*(3), 346–386. <https://doi.org/10.1177/0001839213498591>
- Hennessey, B. A., & Amabile, T. M. (2010). Creativity. *Annual Review of Psychology, 61*, 569–598. <https://doi.org/10.1146/annurev.psych.093008.100416>
- Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984). Development of analogical problem-solving skill. *Child Development, 55*(6), 2042–2055. <https://doi.org/10.2307/1129778>
- Holyoak, K. J., & Thagard, P. (1995). *Mental leaps: Analogy in creative thought*. MIT Press.
- Islam, G., Endrissat, N., & Noppeney, C. (2016). Beyond ‘the eye’ of the beholder: Scent innovation through analogical reconfiguration. *Organization Studies, 37*(6), 769–795. <https://doi.org/10.1177/0170840615622064>
- Jablokow, K. W. (2008). Developing problem solving leadership: A cognitive approach. *International Journal of Engineering Education, 24*(5), 936–954.
- Kajzer, M. I., & Walinga, J. (2017). The creative imperative: The role of creativity, creative problem solving and insight as key drivers for sustainability. *Journal of Cleaner Production, 140*, 1872–1884. <https://doi.org/10.1016/j.jclepro.2016.09.162>
- Kelley, T., & Kelley, D. (2013). *Creative confidence: Unleashing the creative potential within us all*. William Collins.
- Koblin, J. (2015). At Gucci, a messy exit for one designer opens an unlikely door for another. Available at <https://www.nytimes.com/2015/02/26/fashion/at-gucci-a-messy-exit-for-one-designer-opens-an-unlikely-door-for-another.html> (accessed 23 April 2022).
- Kolko, J. (2015). Design thinking comes of age. Available at <https://hbr.org/2015/09/design-thinking-comes-of-age> (accessed 23 April 2022).
- Landry, M. (1995). A note on the concept of “problem.”. *Organization Studies, 16*(2), 315–343. <https://doi.org/10.1177/017084069501600206>
- Langley, A. N. N., Smallman, C., Tsoukas, H., & Van de Ven, A. H. (2013). Process studies of change in organization and management: Unveiling temporality, activity, and flow. *Academy of Management Journal, 56*(1), 1–13. <https://doi.org/10.5465/amj.2013.4001>
- LeCompte, M. D., & Schensul, J. J. (2010). *Conducting ethnographic*. Alta-Mira Press.
- Liu, H.-Y., & Maas, M. M. (2021). ‘Solving for X?’ Towards a problem-finding framework to ground long-term governance strategies for artificial intelligence. *Futures, 126*, 102672. <https://doi.org/10.1016/j.futures.2020.102672>
- Locke, K. (2011). Field research practice in management and organization studies: Reclaiming its tradition of discovery. *Academy of Management Annals, 5*(1), 613–652. <https://doi.org/10.1080/19416520.2011.593319>
- Lyles, M. A., & Thomas, H. (1988). Strategic problem formulation: Biases and assumptions embedded in alternative decision-making models. *Journal of Management Studies, 25*(2), 131–145. <https://doi.org/10.1111/j.1467-6486.1988.tb00028.x>
- Magistretti, S., Ardito, L., & Messeni Petruzzelli, A. (2021). Framing the microfoundations of design thinking as a dynamic capability for innovation: Reconciling theory and practice. *Journal of Product Innovation Management, 38*(6), 645–667. <https://doi.org/10.1111/jpim.12586>
- Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell’Era, C., Stigliani, I., & Verganti, R. (2021). Framing the multifaceted nature of design thinking in addressing different innovation purposes. *Long Range Planning, 55*(5), 102163. <https://doi.org/10.1016/j.lrp.2021.102163>
- March, J., & Simon, H. (1993). *Organizations*. Blackwell.
- Mednick, S. (1962). The associative basis of the creative process. *Psychological Review, 69*(3), 220–232. <https://doi.org/10.1037/h0048850>
- Micheli, P., Wilner, S. J. S., Bhatti, S. H., Mura, M., & Beverland, M. B. (2019). Doing design thinking: Conceptual review, synthesis, and research agenda. *Journal of Product Innovation Management, 36*(2), 124–148. <https://doi.org/10.1111/jpim.12466>
- Moreno, D. P., Hernandez, A. A., Yang, M. C., Otto, K. N., Hölttä-Otto, K., Linsey, J. S., Wood, K., & Linden, A. (2014). Fundamental studies in design-by-analogy: A focus on domain-knowledge experts and applications to transactional design problems. *Design Studies, 35*(3), 232–272. <https://doi.org/10.1016/j.destud.2013.11.002>
- Mueller, J. S., Wakslak, C. J., & Krishnan, V. (2014). Construing creativity: The how and why of recognizing creative ideas. *Journal of Experimental Social Psychology, 51*, 81–87. <https://doi.org/10.1016/j.jesp.2013.11.007>
- Mumford, M. D., Reiter-Palmon, R., & Redmond, M. R. (1994). Problem construction and cognition: Applying problem representations in ill-defined domains. In M. A. Runco (Ed.), *Problem finding, problem solving, and creativity* (pp. 3–39). Ablex Publishing.
- Pedersen, S., Bogers, M. L. A. M., & Clausen, C. (2022). Navigating collaborative open innovation projects: Staging negotiations of actors’ concerns. *Creativity and Innovation Management, 31*(2), 306–321. <https://doi.org/10.1111/caim.12492>
- Peirce, C. S. (1934). The collected papers of Charles Sanders Peirce. In *Pragmatism and Pragmaticism* (Vol. V). Harvard University Press.
- Posen, H. E., Keil, T., Kim, S., & Meissner, F. D. (2018). Renewing research on problemistic search: A review and research agenda. *Academy of Management Annals, 12*(1), 208–251. <https://doi.org/10.5465/annals.2016.0018>
- Pribram, K. H. (1999). Brain and the creative act. In *Encyclopedia of creativity* (pp. 213–217). Academic Press.
- Reiter-Palmon, R., & Illies, J. J. (2004). Leadership and creativity: Understanding leadership from a creative problem-solving perspective. *The Leadership Quarterly, 15*(1), 55–77. <https://doi.org/10.1016/j.leaqua.2003.12.005>
- Reiter-Palmon, R., Mumford, M. D., Boes, J. O. C., & Runco, M. A. (1997). Problem construction and creativity: The role of ability, cue consistency, and active processing. *Creativity Research Journal, 10*(1), 9–23. [https://doi.org/10.1207/s15326934crj1001\\_2](https://doi.org/10.1207/s15326934crj1001_2)



- Reiter-Palmon, R., & Murugavel, V. (2018). The effect of problem construction on team process and creativity. *Frontiers in Psychology, 9*, 2098. <https://doi.org/10.3389/fpsyg.2018.02098>
- Reiter-Palmon, R., & Robinson, E. J. (2009). Problem identification and construction: What do we know, what is the future? *Psychology of Aesthetics, Creativity, and the Arts, 3*(1), 43–47. <https://doi.org/10.1037/a0014629>
- Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan, 42*(7), 305–310. <http://www.jstor.org/stable/20342603>
- Richardson, R., & Kramer, E. H. (2006). Abduction as the type of inference that characterizes the development of a grounded theory. *Qualitative Research, 6*(4), 497–513. <https://doi.org/10.1177/1468794106068019>
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155–169. <http://www.jstor.org/stable/4531523>, <https://doi.org/10.1007/BF01405730>
- Runco, M. A. (2004). Creativity. *Annual Review of Psychology, 55*, 657–687. <https://doi.org/10.1146/annurev.psych.55.090902.141502>
- Runco, M. A. (2014). Chapter 1 - Cognition and creativity. In M. A. Runco (Ed.), *Creativity* (2nd ed.) (pp. 1–38). Academic Press. <https://doi.org/10.1016/B978-0-12-410512-6.00001-1>
- Runco, M. A., & Chand, I. (1995). Cognition and creativity. *Educational Psychology Review, 7*(3), 243–267. <https://doi.org/10.1007/BF02213373>
- Silk, E. M., Reckemmer, A. E., Daly, S. R., Jablolkow, K. W., & McKilligan, S. (2021). Problem framing and cognitive style: Impacts on design ideation perceptions. *Design Studies, 74*, 101015. <https://doi.org/10.1016/j.destud.2021.101015>
- Simonton, D. K. (1999). Creativity as blind variation and selective retention: Is the creative process Darwinian? *Psychological Inquiry, 10*(4), 309–328. [https://doi.org/10.1207/S15327965PLI1004\\_4](https://doi.org/10.1207/S15327965PLI1004_4)
- Simonton, D. K. (2013). Creative thought as blind variation and selective retention: Why creativity is inversely related to sightedness. *Journal of Theoretical and Philosophical Psychology, 33*(4), 253–266. <https://doi.org/10.1037/a0030705>
- Stigliani, I., & Ravasi, D. (2012). Organizing thoughts and connecting brains: Material practices and the transition from individual to group-level prospective sensemaking. *Academy of Management Journal, 55*(5), 1232–1259. <https://doi.org/10.5465/amj.2010.0890>
- Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage Publications, Inc.
- Strauss, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511557842>
- Thagard, P. (1996). *Mind: Introduction to cognitive science*. MIT Press.
- Thagard, P., & Shelley, C. (1997). Abductive reasoning: Logic, visual thinking, and coherence. In M. L. Dalla Chiara, K. Doets, D. Mundici, & J. van Benthem (Eds.), *Logic and scientific methods* (pp. 413–427). Springer. [https://doi.org/10.1007/978-94-017-0487-8\\_22](https://doi.org/10.1007/978-94-017-0487-8_22)
- Troise, C., Corvello, V., Ghobadian, A., & O'Regan, N. (2022). How can SMEs successfully navigate VUCA environment: The role of agility in the digital transformation era. *Technological Forecasting and Social Change, 174*, 121227. <https://doi.org/10.1016/j.techfore.2021.121227>
- Tseng, I., Moss, J., Cagan, J., & Kotovsky, K. (2008). The role of timing and analogical similarity in the stimulation of idea generation in design. *Design Studies, 29*(3), 203–221. <https://doi.org/10.1016/j.destud.2008.01.003>
- Unsworth, K. (2001). Unpacking creativity. *Academy of Management Review, 26*(2), 289–297. <https://doi.org/10.5465/amr.2001.4378025>
- Van Maanen, J. (2011). Ethnography as work: Some rules of engagement. *Journal of Management Studies, 48*(1), 218–234. <https://doi.org/10.1111/j.1467-6486.2010.00980.x>
- Vandenbosch, B., & Higgins, C. (1996). Information acquisition and mental models: An investigation into the relationship between behaviour and learning. *Information Systems Research, 7*(2), 198–214. <https://doi.org/10.1287/isre.7.2.198>
- Ward, T. B., & Kolomyts, Y. (2010). Cognition and creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 93–112). Cambridge University Press. <https://doi.org/10.1017/CBO9780511763205.008>
- Woodman, R. W., & Schoenfeldt, L. F. (1990). An interactionist model of creative behavior. *The Journal of Creative Behavior, 24*(1), 10–20. <https://doi.org/10.1002/j.2162-6057.1990.tb00525.x>
- Wu, C.-L., Huang, S.-Y., Chen, P.-Z., & Chen, H.-C. (2020). A systematic review of creativity-related studies applying the remote associates test from 2000 to 2019. *Frontiers in Psychology, 11*, 573432. <https://doi.org/10.3389/fpsyg.2020.573432>

## AUTHOR BIOGRAPHIES

**Cristina Tu Anh Pham** is a Ph.D. candidate at Politecnico di Milano, Italy. She is also a senior researcher in Leadin' Lab (Leadership and Innovation Lab) and the Observatory of Design Thinking for Business. Her research focuses on the creative logics of problem framing in innovation. It investigates the way individuals and teams interpret the complex and ambiguous innovation environment to formulate original problems worth solving. She has published on *Innovation: Organization and Management Journal* and *Industrial Marketing of Management*.

**Stefano Magistretti** is assistant professor of Agile Innovation at the School of Management, Politecnico di Milano, and a senior researcher in the Leadin' Lab, the Laboratory of LEAdership, Design, and INnovation. Within the School of Management, he also serves as director for the Observatory Design Thinking for Business. Moreover, he serves as Social Media Editor for *Innovation: Organization and Management*. Concerning the research activities, he has published conference articles and chapters in edited books, as well as articles in journals such as *Journal of Product Innovation Management*, *Long Range Planning*, *Industrial Marketing Management*, *Technological Forecasting and Social Change*, *Industry & Innovation*, *R&D Management*, *Business Horizons*, *Creativity and Innovation Management*, *Management Decision*, *Journal of Knowledge Management*, *Research Technology Management* and *Innovation: Organization and Management*.

**Claudio Dell'Era** is full professor in Design Thinking for Business at the School of Management - Politecnico di Milano, where he serves also as Co-Founder of Leadin' Lab, the Laboratory of LEAdership, Design and INnovation. He is also Director of the Observatory 'Design Thinking for Business' of the School of Management - Politecnico di Milano. Research activities developed by Claudio Dell'Era are concentrated in the areas of design thinking and design strategy. He has published more than 100 chapters in edited books and papers published in conference proceedings and

leading international journals such as *Entrepreneurship Theory and Practice*, *Journal of Product Innovation Management*, *Long Range Planning*, *Technology Forecasting and Social Change*, *R&D Management*, *International Journal of Operations & Production Management*, *Industry & Innovation*, *Creativity and Innovation Management*, *Business Horizons*, and many others.

**How to cite this article:** Pham, C. T. A., Magistretti, S., & Dell'Era, C. (2023). How do you frame ill-defined problems? A study on creative logics in action. *Creativity and Innovation Management*, 1–24. <https://doi.org/10.1111/caim.12543>

APPENDIX

TABLE A1 Additional evidence of creative operations and problem representations produced during the application of analogical reasoning

Aggregate dimension: Analogical reasoning		
Creative operations	Description	Mental representations (produced)
Assumption-driven perception	Individuals formulate assumptions based on their knowledge reference system. They find parallels between what is described in the information and what they know from experience, common and diffused knowledge or their beliefs	<p><b>Description:</b> G is driven by the general understanding of the concept of packaging-free as sustainable. He projects this generalized understanding on the problem representation</p> <p><b>Representation:</b> How to provide distribution that is perceived as sustainable by customers (from G's general understanding)</p>
	<p>Input: Negozio alla Spina description—that is, the context (packaging-free chain store in Milan, easily reachable by public transport), the format (packaging-free, meaning that everyone can bring their own bags and boxes for food conservation), and customers (young couples and families)</p> <p>So, by reading its description, Negozio alla Spina takes pride in being a packaging-free store. Certainly, I assume the customers who usually go there are also sensitive to the sustainability theme. So, we should rethink distribution during COVID in a way that is sustainable – for instance, no underpaid riders' (G)</p> <p><b>Context:</b> The team is framing the problem of a car sharing service during and after COVID-19</p>	<p><b>Description:</b> M's interpretation of the problem is driven by his personal experience with car sharing in Milan. He project it onto the experience of other users in other cities</p> <p><b>Representation:</b> How to improve car sharing accessibility to all the citizens of a city (from M's experience)</p>
	<p>Possibilità di coprire il tragitto casa-lavoro per gli utenti che abitano a Milano</p>	<p>Well, especially in Milan—but I assume also in other cities—people use car sharing according to where they live. I think this is big pain point: the map range and availability, we need more of it! Of course, I'm just assuming things, we should also see what the data says' (M)</p>

(Continues)

TABLE A 1 (Continued)

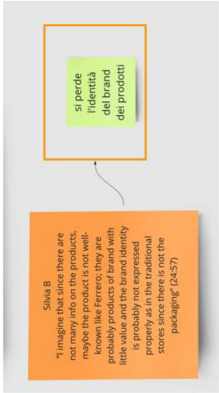

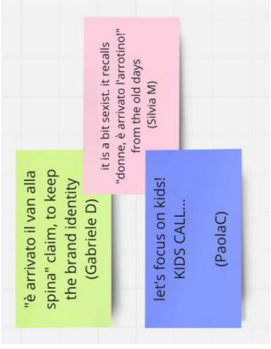
Aggregate dimension: Analogical reasoning	
Creative operations	Description
<p><b>Representative evidence for the creative operation</b></p> <p><b>Context:</b> The team is framing the problem of <i>Negoziò alla Spina</i></p>  <p><b>Mental representations (produced)</b></p> <p><b>Description:</b> S believes in the importance of packaging and the brand. She leverages a comparative parallel between <i>Negoziò alla Spina</i> and Ferrero to identify the problem</p> <p><b>Representation:</b> How not to lose the brand's identity while offering packaging-free items (from S's beliefs)</p>	<p><b>Metaphor activation</b></p> <p>Individuals map and compare the information from the ill-defined problem with features of another product, service or culture</p> <p><b>Context:</b> The team is framing the problem of carpooling and car sharing during COVID</p> <p>Post-it on the left 'Group car rental—for example, dinner with people I see every day'</p> <p>Post-it on the right 'Micro-rental with trustworthy people for the weekend—for example, Netflix subscription'</p>  <p><b>Description:</b> The participants frame the carpooling problem by drawing analogies with other situations (i.e. during COVID you could have dinner only family and close friends, you create a Netflix subscription with other family members or friends that act as your family members)</p> <p><b>Representation:</b> How to offer a car pooling that for groups of people that are familiar with each other (from other products)</p> <p><b>Description:</b> M leverages a parallel with a distant culture to interpret the problem of packaging-free food during COVID-19</p> <p><b>Representation:</b> How to provide a sense of hygiene and health safety to consumers of packaging-free food (from M's knowledge of the Japanese culture)</p>

TABLE A2 Additional evidence of creative operations and problem representations produced during the application of associative thinking

Aggregate dimension: Associative thinking		Representative evidence for the creative operation	Mental representations (produced)
<b>Creative operations</b>	<b>Description</b>		
Serendipitous detection	From the noisy information, individuals suddenly find unexpected associations that recall a past interpretation of the problem. It can activate from unconscious variations in the mind, and manifests as a memory that brings perspective to the problem	<p><b>Context:</b> Participants are asked to work individually and think about the pain points and the societal macro-tensions that Car2Go (a car sharing company) faces during the pandemic. As they finish their individual reflections, they share their thoughts with the other participants. Sparked by the first contribution, they discuss the macro-tension of health security and hygiene and the scenario of people using the service for their daily commute</p> <p>'I know that we are talking about health safety, but I was thinking "what about personal security?": I am a woman and I live alone in Bologna ...' (M)</p> <p><b>Context:</b> During the solution generation phase, participants detail their multi-modal mobility solution for Milan's public transport (ATM). In particular, they build the solution through Edoardo's customer journey (a persona provided by the facilitator). The facilitator starts the conversation: 'Edoardo is a sales agent. I guess he is coming to Milan, maybe he has a meeting with a client. At the start of the journey, he has to plan for the trip'</p> <p>'Yes. And the weather! [pause] Edoardo makes an assessment of the situation in Milan; for example, he considers the information related to the weather [pause]. Because I move a lot in Milan with a moped, bike, car... and the choice of vehicle also depends on the weather' (B)</p>	<p><b>Description:</b> Although the group is framing the problem under the lens of health safety M. bursts in the conversation with a sudden recall of her own interpretation due to her own experience (i.e. personal security)</p> <p><b>Representation:</b> How to provide a sense of personal security (from M's personal need)</p> <p><b>Description:</b> B suddenly narrows the frame of the planning problem within the synchronization of different weather conditions. She is driven by a connection with her own needs</p> <p><b>Representation:</b> How to plan the journey according to weather conditions (from B's personal need)</p>
			<p><b>Description:</b> S perceives G's proposal as sexist, since she finds similarities with the script that old door-to-door knife grinders used to sell to housewives</p> <p><b>Representation:</b> How to communicate the message without any subtext (from S's interpretation)</p>
Nuance-driven differentiation	The individual identifies the dissimilarities or nuances that hide behind the analysed information by connecting the cues with the depth of his/her/their own knowledge. The individual forces a set of underlying dissimilar interpretations	<p><b>Context:</b> The team is discussing the problem of remote work. They are focusing on the issue of managing geographical distance and boundaries from the perspective of the availability and intermediation of digital services</p> <p>'When it comes to working with 'geographical boundaries' the core issue is around 'trust' rather than the intermediation of digital services. Because no matter where you are, the quality of your work shouldn't change. In fact, having digital services in the workplace available everywhere reduces</p>	<p><b>Description:</b> R pivots from the problem of digital services intermediation to a connected problem: building trust. She believes that building trust is the true core of the problem</p> <p><b>Representation:</b> How to build trust in the workplace while being geographically distant (from R's knowledge depth)</p>

(Continues)

TABLE A2 (Continued)

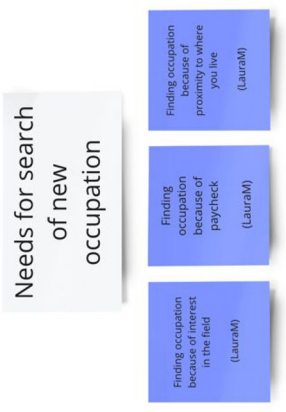
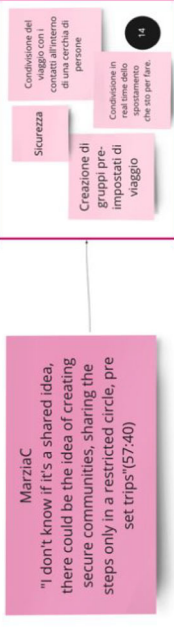

Aggregate dimension: Associative thinking	Description	Mental representations (produced)
Creative operations	<p>Representative evidence for the creative operation</p> <p>the geographical boundaries, and therefore it all boils down to the trust relationship with the leader' (R)</p>	 <p><b>Description:</b> L splits the initial problem of job search into three facets. She applies her nuanced understanding of the motivations for a new occupation to find the three problem representations</p> <p><b>Representation:</b> How to build finding a new job that suits personal interests vs. how to find a new job that suits economic interests vs. how to find a new job that suits commuting needs (from L's deep understanding of motivations)</p>
Gestalt recombination	<p>Individuals draw higher-order associations between different information, knowledge inputs and interpretations</p>	<p><b>Description:</b> M creates an umbrella representation that encompasses the representations of the other team members</p> <p><b>Representation:</b> How to create secure communities for pre-set trips (from M's association of team representations)</p>
Gestalt recombination	<p><b>Context:</b> The team is discussing carpooling, they have just gone through a brainstorming session. Some of the post-it notes (cluster on the right) read 'security', 'trip sharing with a restricted number of contacts', 'pre-defined groups for trips'</p>	
Gestalt recombination	<p><b>Context:</b> The team is discussing carpooling. They have just gone through a brainstorming session. Some of the post-it notes (cluster on the right) read 'booking cars for an entire hour', 'real-time sharing of scheduled trip' and 'synchronized calendar'</p> <p>'Well, all these post-it notes can be connected. Booking for the entire hour, synchronization of calendars, and real-time sharing. I see a shared booking'</p>	<p><b>Description:</b> L creates an umbrella representation that encompasses the representations of the other team members</p> <p><b>Representation:</b> How to create a shared car rental booking (from M's association of team representations)</p>
Gestalt recombination		

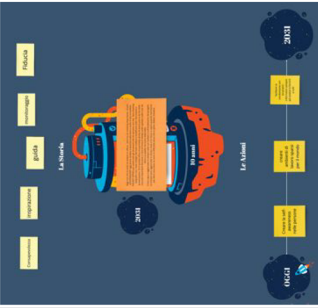
TABLE A3 Additional evidence of creative operations and problem representations produced during the application of abductive reasoning

Aggregate dimension: Abductive reasoning			
Creative operations	Description	Representative evidence for the creative operation	Mental representations (produced)
Critical investigation	Individuals inform their interpretation by adopting an inquisitive nature aimed at assessing some preliminary hypotheses by capturing as many cues as possible. They proceed through (rhetorical) in-depth questions and iterations	<p><b>Context:</b> The team discusses the home delivery system of retails.</p> <p>'Have you thought about the number of stores in Milan that have started home deliveries? How are they managing it? I think there could be some hidden complications, like there could be new costs associated with the delivery—Do you know something about it?' (F)</p> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;"> <p>Maggiore attenzione alla sfera familiare e comfort zone in cui non ci si sente in pericolo</p> </div> <div style="border: 1px solid black; padding: 5px; width: 150px;"> <p>Meno spostamenti non necessari, si esce se ce n'è bisogno</p> </div> </div> <div style="margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; width: 150px;"> <p>Incremento di acquisti online e di food delivery come alternativa alla "cena fuori casa"</p> </div> </div> <p><b>Context:</b> Car sharing. Post-it notes on the problem of reduced use of public and private transport due to the decrease in social activities; L iterates on the topic of sociability through a question</p> <p><b>Quote:</b> 'How can Car2Go increase sociability? We give people a reason to leave home again, we increase sociability' (L)</p>	<p><b>Description:</b> F asks almost rhetorical questions on home deliveries aimed at collecting additional information that supports or confutes her initial hypothesis on the hidden complications of home delivery</p> <p><b>Representation:</b> How to manage the complications of home delivery systems (from F's pre-defined hypothesis)</p> <p><b>Description:</b> L iterates on the problem with a rhetorical question aimed at steering the conversation towards what he believes is the real problem (decrease in sociability due to COVID)</p> <p><b>Representation:</b> How to increase sociability rather than the use of Car2Go (from L's pre-defined hypothesis)</p>
Imaginative construction	Individuals imagine a whole new world that allows making sense of the cues, thus determining the potential or eventual occurrence of a fact that could be a scenario, future change or occurrence of issues	<p><b>Context:</b> The team is discussing the future of HR and how it will evolve in 10 years</p> <p>'I imagine that in the future 2030 AI will replace humans in doing all those boring tasks that have nothing to do with "human resources", but much to do with the company's bureaucracy. There are some hints about it already. Maybe once HR gets rid of these boring activities not related to the care of HUMAN resources, HR will have more time to</p>	<p><b>Description:</b> E imagines a whole future scenario to build a problem representation that gives sense to surprising hints from the environment.</p> <p><b>Representation:</b> How to make HR more focused on humans in human resources (from L's creation of a scenario)</p>

(Continues)

TABLE A3 (Continued)

Aggregate dimension: Abductive reasoning

Creative operations	Description	Representative evidence for the creative operation	Mental representations (produced)
personally follow employees and support their growth, give advice, create an ad hoc training course' (E)		<p>personally follow employees and support their growth, give advice, create an ad hoc training course' (E)</p>	<p><b>Description:</b> C creates a story of future leaders starting from singular keywords  <b>Representation:</b> How the future leader becomes more of a mentor than a manager (from C's creation of a story)</p>
			<p><b>Context:</b>                      C builds a story from the words                      'awareness',                      'inspiration',                      'guidance',                      'monitoring',                      and 'trust'                      The story is built to define what the future of the leader and the work environment will be</p>