Bridging cognitive scripts in multidisciplinary academic spinoff teams: A process perspective on how academics learn to work with non-academic managers

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ABSTRACT

This paper introduces a process model of how academics learn to *bridge different cognitive scripts,* thereby learning to collaborate with non-academic managers in the context of multidisciplinary academic spinoff (ASO) teams. Whereas prior research has taken a static perspective, showing that cooperation in ASO teams is challenging due to differences in cognitive scripts, we take a dynamic perspective, leveraging rich, longitudinal data on a single case to theorize how such cooperative challenges can be overcome. We reveal two aspects of this process. One is cognitive and intrapersonal, in which academics reconsider their own beliefs and understandings of their venture and the commercial world. The other is social and interpersonal, in which academics reconsider the way they collaborate with others.

1. Introduction

Academic spinoffs (ASOs)—i.e., new ventures founded and managed by university scientists (Roche et al., 2020)—often face obstacles when transforming scientists' discoveries into commercially viable new ventures (Colombo et al., 2010; Leyden, 2016; Mustar et al., 2006; Wright et al., 2007). Academics—due to their scientific training and experience—typically lack the skills, knowledge, or even mindset required to commercialize their scientific inventions (Jain et al., 2009). One obvious way to overcome this challenge is to invite non-academic managers to join the ASO as co-founders or managers who can contribute commercial expertise to the new venture (Storey and Tether, 1998; Vanaelst et al., 2006; Vohora et al., 2004). Such formation of a *multidisciplinary ASO team* improves the chances of successful commercialization (Ben-Hafaïedh et al., 2018; Mathisen and Rasmussen, 2019; Visintin and Pittino, 2014).

Yet, it can be difficult for academics and non-academic managers to collaborate in multidisciplinary ASO teams. In particular, research has shown that academics—due to their scientific training and experience—and non-academic managers—with commercial training and experience—may have different *cognitive scripts* (Cronin and Weingart, 2007; Siegel et al., 2003), that is, different "procedural knowledge

structure[s] or schema[s] for understanding and enacting behaviors" (Gioia and Manz, 1985, p. 527). Such differences in cognitive scripts hamper communication and coordination, resulting in dysfunctional collaborative dynamics that stall the performance of the ASO (O`Kane et al., 2015).

To avoid dysfunctional collaborative dynamics, or failure to align activities between members of the ASO team, prior research has suggested that multidisciplinary ASO teams should be set up in a way that ensures some overlap in cognitive scripts between academics and non-academic managers already from the outset since limiting cognitive differences within the ASO team makes functional (instead of dysfunctional) collaboration more likely (Jain et al., 2009; Nooteboom et al., 2007). However, it also brings two disadvantages. First, it undermines the very purpose of a multidisciplinary team, which is to benefit from broad experience rather than narrowing it down. Second, and most importantly, the option is simply not available to most academics in ASOs, who wish to commercialize their scientific discoveries but have only limited cognitive overlap with non-academic managers. For these academic founders, a more helpful approach is *learning to bridge cognitive differences*, rather than limiting them or giving up merely because such differences are too substantial.

Surprisingly, however, prior research offers little advice on how

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academics can learn to work together with non-academic managers. More specifically, even though we have rich insights into why dysfunctional collaborative dynamics occur *due to* differences in cognitive scripts (Ben-Hafaïedh et al., 2018; Diánez-González and Camelo-Ordaz, 2016; Nooteboom et al., 2007), we know far less about the process through which cognitive differences can be overcome, apart from limiting them in the first place. In the present paper, we address this gap. We ask: *how can academics learn to bridge different cognitive scripts instead of limiting them—thereby learning to collaborate with non-academic managers in the context of multidisciplinary academic spinoff (ASO) teams?*

To answer this question, we engage in an inductive, longitudinal case study, following one multidisciplinary ASO team—Foodtech—over eight years (2010–2018). During this period, the team experienced both collaborative failures and collaborative successes. To answer our research question, we rely on both interviews and substantial archival data (e-mails and board meeting documents). The benefit of such a rich, longitudinal data set is that it allows us to theorize on the process through which Foodtech academics learned to collaborate with non-academic managers. The result is a novel understanding of how such learning unfolds through two intertwined processes: (i) an *intrapersonal*, cognitive process, through which the academics reconsidered their own beliefs and understandings about their venture and the commercial world, and (ii) an *interpersonal*, social process, through which they reconsidered the collaborative dynamics of their multidisciplinary ASO team.

As our core contribution, we offer a process perspective that shows why multidisciplinary ASO teams do not need to have an optimal configuration of team members right from the start. Instead, our findings point to a more versatile capacity of academics to learn how to bridge cognitive scripts, irrespective of their initial cognitive distance from managerial colleagues. This developmental view is relevant and useful to many academics with startup ambitions, not just those who have an a priori understanding of the commercial world.

2. Theoretical background

2.1. The role of non-academic managers in ASOs

In multidisciplinary ASO teams, the scientific expertise of academics is complemented by the commercial or business expertise of non-academic managers. Thus, the two groups share responsibility for the decision-making (Lockett et al., 2003; Vanaelst et al., 2006). Such multidisciplinary ASO teams tend to achieve a shorter time to market (Knockaert et al., 2011) and are more commercially viable (Ben-Hafaïedh et al., 2018). Often, they are also appreciated by investors, who see them as a sign of credibility (Rasmussen et al., 2011; Vohora et al., 2004).

2.2. Challenges of collaborating under different cognitive scripts

While multidisciplinary ASO teams have many benefits, the different backgrounds of academics and non-academic managers also have drawbacks. Academics often have a strong scientific orientation. This shapes their role identities (Jain et al., 2009) and personal values (Hamilton and Schumann, 2016) in ways that differ from non-academic managers, who typically have a more commercial or business-oriented mindset (Colombo et al., 2010; Vohora et al., 2004).

In research on multidisciplinary ASO teams, these differences are often referred to as differences in *cognitive scripts* (Cronin and Weingart, 2007; Siegel et al., 2003), that is, a "procedural knowledge structure or schema for understanding and enacting behaviors" (Gioia and Manz, 1985, p. 527). For example, Cronin and Weingart (2007) as well as Lam (2011) find that individuals with scientific training often develop a mindset, in which precision and accuracy are paramount, resulting in a tendency to stay well within the letter of the law. Managers, in contrast,

especially those with entrepreneurial experience, are more likely to experiment and interpret rules more flexibly (Cronin and Weingart, 2007). Moreover, while entrepreneurial experience might help individuals to become more tolerant of failure (Cope, 2005; Gano-An and Gempes, 2020), scientists tend to experience failure more intensely, since it can endanger their academic prestige and reputation (Lam, 2011).

Because of their differences in cognitive scripts, academics and non-academic managers often experience dysfunctional collaborative dynamics when working together in the context of multidisciplinary ASO teams (Mathisen and Rasmussen, 2019), meaning that they fail to align activities due to miscommunications or misunderstandings. Interestingly, dysfunctional collaborative dynamics often prevail even in cases where academics decide *willingly* to work with non-academic managers (O'Kane et al., 2015), as well as when academics have experience in more applied and commercially-oriented research (Colombo et al., 2010; Vohora et al., 2004).

Since differences in cognitive scripts make dysfunctional collaborative dynamics likely, prior research has suggested that multidisciplinary ASO teams should be set up in a way that ensures a certain degree of overlap in cognitive scripts among academics and managers (Jain et al., 2009; Nooteboom et al., 2007). For example, it has been suggested that non-academic managers should only join the ASO in later phases after the academics have gained some commercial experience that allows them to collaborate better with non-academic team members (Jain et al., 2009; Jousma and Scholten, 2009; Vohora et al., 2004).

2.3. Learning to bridge cognitive differences instead of limiting them

What prior research has neglected, though, is that setting up a multidisciplinary ASO team in a way that ensures a cognitive overlap also comes with substantial disadvantages. First, it is precisely the differences between academics and non-academics that constitute the benefit of a multidisciplinary ASO team. Hence, limiting cognitive differences also limits the inherent potential of such a team. Second, to ensure a cognitive overlap, academics will need to encounter some commercial experience before onboarding non-academic managers. This option is simply not available to most academics, who have their training and their career in the scientific community. Moreover, there are strong indications that non-academic managers are most beneficial in the early stages of the ASO's development before academics had a chance to build commercial experience. Indeed, when non-academic managers are involved early on, they have more scope to push the venture in a commercially viable direction, generating long-term benefits (Rasmussen et al., 2011; Vohora et al., 2004). Thus, it remains an important but undertheorized problem how academics in a multidisciplinary ASO team can learn to *bridge* different cognitive scripts, instead of limiting cognitive differences already from the start, thereby achieving a more functional collaborative dynamic. The present study addresses this research problem.

3. Methods

Because of the need to build a process-oriented theory of how academics in multidisciplinary ASO teams can learn to bridge different cognitive scripts instead of limiting them, we rely on a single, longitudinal case study (Edmondson and McManus, 2007).

3.1. Case selection

The single case in focus is Foodtech,[1] an ASO based in Sweden, active in the food industry. Foodtech was founded in October 2010. Three

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scientists at a leading European university had developed a measurement technique revealing how blood glucose and insulin production in the human body is affected by eating different types of bread. Seeing commercial potential in their technique, the inventors obtained seed funding from the university and from government and private agencies, which they dedicated to developing their technology. After incorporation, two non-academic managers were invited to join the team as board members with an active role in daily operations. After a while, however, severe collaborative problems emerged, meaning that the academics and non-academic managers of Foodtech failed to align and advance their activities due to frequent misunderstandings and miscommunication. In our study, we analyze how these dysfunctional collaborative dynamics emerged, as well as the process that led to the Foodtech academics gradually learning to have a more functional collaboration with the non-academic managers in their team. As such, Foodtech constitutes an unusually rich opportunity to answer our research question.

3.2. Data collection

Our data encompasses interviews, emails, and corporate documents; see Table 1.

3.2.1. Interviews

We conducted 20 interviews, encompassing all nine individuals that were part of the Foodtech team between 2010 and 2018. All interviews followed a similar protocol. Informants were asked to outline their role in Foodtech; tell the story of the invention; comment on their knowledge and experience; and describe their working relationships with each other. Many informants were interviewed multiple times to ask follow-up questions as well as triangulate responses across time. Interviews lasted one to two hours and were transcribed. To guard against memory failure, informants were continually asked to verify events using dates and names, and were also asked to provide documentation to verify events whenever possible (e.g., referring to emails or board meetings and memos, discussed below). Moreover, we developed a timeline to capture how events unfolded over time, which was then presented to our informants for verification.

3.2.2. Emails and documents

In November, the first author was granted access to a digital folder containing 990 archived emails between Foodtech members, covering the period October 2011 until November 2017. These emails were the ones that Foodtech members had themselves archived as they concerned operational issues, such as daily tasks or activities related to the development of Foodtech. Foodtech members did not select (or delete) any emails from this archive prior to sharing it with the first author. Emails were pseudonymized before being shared with the research team. We also accessed 62 board meeting minutes and memos, covering the period from March 2011–June 2017.

3.3. Data analysis

3.3.1. First-order coding: creating a time-sensitive representation of critical events unfolding about collaborative dynamics and learning

Our initial coding focused on identifying critical events and informants' interpretations of them. In our case, a critical event refers to a temporally bounded instance that significantly impacted academics' learning about how to work with non-academic managers (Langley et al., 2013). Based on the interview transcripts and the content of all emails and corporate documents, we identified critical events and wrote summaries, that is, first-order codes. Over time, this resulted in a list of 173 first-order codes, sorted in chronological order. This list gave us an overview of the development of our case that enabled us to uncover how the collaborative dynamics changed over time. From becoming dysfunctional (October 2010–March 2012), followed by an intensive learning period (April 2012–September 2012) resulting in functional

Table 1
Summary of interviews, emails, and document.

Interviewees	Age/gender	Description	No. of interviews
Academics (Catherin)	73/F	Catherin is a professor of food engineering. She has a background in food and bioscience. She previously worked at Nestlé's research center in Switzerland and was involved in food-based research at ABB. She is a co-founder and co-owner of Foodtech.	5
(Elizabeth)	45/F	Elizabeth is an associate professor of applied food science. Her research focuses on optimizing blood-sugar regulation in the body after the ingestion of carbohydrate-rich foods. She has more than 15 years' experience in implementing meal studies. She is a co-founder and co-owner of Foodtech.	5
(Marta)	43/F	Marta is an associate professor of food technology. She has specialized in the properties of starch and the physiochemical properties of starch-rich systems. She is a co-founder and co-owner of Foodtech.	1
(Jeni)	28/F	Jeni is a researcher who joined Foodtech in February 2016 to test the recipe for the firm's bread product and serve as a product developer.	1
Non-academic managers (Carmen)— Holding Co. (A)	55/F	Carmen is a board representative and a member of a holding company that invested in Foodtech. With a background as a CEO and founder of several bioengineering companies, Carmen has more than 20 years' of experience in business development and raising venture capital. Carmen was invited to sit on the board of Foodtech in June 2013.	1
(Oloff)— Holding Co. (B)	75/M	Oloff is a board member and representative of another holding company that invested in Foodtech. He previously worked as a business consultant. Oloff joined Foodtech in June 2010 and left end of March 2012.	1
(Leif)	53/M	Leif is an entrepreneur with many years of experience in business development, fundraising, and new venture creation. Leif joined Foodtech in June 2010 and left end of March 2012.	3
(Tobias)	63/M	Tobias initially joined Foodtech as a consultant in October 2012, but was later invited in November 2012 to join Foodtech as CEO. He has extensive experience in the baking industry. Tobias left Foodtech in 2014 and was replaced by Christopher in the same year.	2
(Christopher)	29/M	Christopher joined Foodtech in 2014 following the exit of Tobias. He holds a degree in entrepreneurship and was particularly involved in commercializing the technology. Christopher remained until the last day we conducted our interviews with the Foodtech team.	1

Table 1 (*continued*)

Interviewees	Age/gender	Description	No. of interviews
			20 interviews
Documents		Board-meeting notes, end-of-year reports, presentations, etc.	*62 documents*
Emails		Emails from October 2011–November 2017	*990 emails*

collaborative dynamics (from October 2012–onwards).

After this observation, we decided to focus our analysis on the intensive learning period we identified in the year 2012, to further understand how Foodtech academics had learned to collaborate with non-academic managers. We analyzed critical events from this period as well as informants' interpretations of them in detail, seeking to map the developments over time. In line with what Langley et al. (2013) term "temporal bracketing," we divided 2012 into three consecutive learning phases based on this first-order analysis. In April–July 2012, the academics learned about the venture; in August–September 2012, they learned about themselves; and from October 2012 onwards, they learned about their team. Thus, while the subject of learning remained the Foodtech academics (i.e., they were always the ones who "learned"), the object of learning (i.e., what they learned *about*) shifted over time.

3.3.2. Second-order coding: linking empirical observations to abstract concepts

When bracketing our list of events according to the three learning phases, we noted how each phase encompassed three elements: actions, reflection on those actions, and reflection about how to take future action. Thus, we made such action-reflection cycles an important theme in our data. At this point, we also engaged with the literature on learning to make sense of our empirical findings, in line with established practices in the inductive qualitative analysis (Miles and Huberman, 1994). Specifically, we used Kolb's (1984) learning framework in a sensitizing way to frame and guide our analysis of the specific mechanisms and processes that were relevant for understanding how academics learned to work with non-academic managers.

Kolb (1984) describes learning as a cyclical process encompassing four mechanisms: (i) concrete learning, (ii) abstract conceptualization, (iii) reflective observation, and (iv) active experimentation. Through our inductive work, we found the first three of these mechanisms to be relevant.[2] We grouped observations according to (i) *action orientation*, which corresponds to academics' concrete learning experiences; (ii) *abstract conceptualization*, which manifests how academics made sense of this experience by interpreting it and comparing it to what they had done and already knew; and (iii) *future-oriented reflection*, which refers to reflective observation regarding how academics relied on their experience to inform future action. By relating our first-order codes to these general themes, we were able to analyze and observe how academics engaged in action orientation, abstract conceptualization, and future-

oriented reflection in the three different phases of learning. In this way, we could develop second-order concepts that described the specific manifestation of Kolb's learning mechanisms in our context.

As discussed in Section 2, the cognitive script is a core concept in prior research on multidisciplinary ASO teams, and it was also a salient theme in our data. Specifically, through our list of first-order codes, we could identify how academics gradually moved in their reasoning from first being *aware* of different cognitive scripts, to be able to *comprehend* them, and finally acquiring the capacity to *bridge* them across the three learning phases we observed.

In this process of aggregating our 176 first-order codes into second-order concepts, we also discovered an additional theme that was not salient in either Kolb's original model, or research on multidisciplinary ASO teams, which we term *perceived scope of responsibility*. Under the dysfunctional collaborative dynamics, the Foodtech academics had an *atomistic* scope of responsibility, meaning that they saw themselves as only responsible for scientific matters, not commercial ones. In all subsequent phases, however, they assumed a *holistic* responsibility, meaning that they took responsibility for both the commercial and the scientific aspects of the venture. In our case, this shift in the perceived scope of responsibility was an important trigger for academics' learning processes.

In sum, by moving between established theory and our case data, we gained a conceptual overview of how Foodtech academics learned to collaborate with non-academic managers based on *what* academics learned over time (i.e., about themselves, the venture, and the team); *how* they learned (i.e., through concrete learning, abstract conceptualization, and reflective observation) and the *output* of those learning mechanisms (i.e., first becoming aware of different cognitive scripts, then comprehending them, and finally bridging them), as well as the *triggering condition* for this learning to take place (i.e., the perceived scope of responsibility).

3.3.3. Development of a process model

Having coded our data and abstracted it into conceptual themes, we began our processual analysis, seeking to uncover dynamic interrelationships between the concepts we had uncovered. To do so, we followed established practices in process theorizing (Langley et al., 2013) and integrated our observations into a visual map; see Fig. 1.

In the final stage of our analysis, we then integrated these first- and second-order observations into a process model; see Fig. 2 (Gioia et al., 2013). While Fig. 1 illustrates how this process was manifested in Foodtech, Fig. 2 represents an abstract conceptualization relevant to multidisciplinary ASO teams in general. The model is discussed in detail in Section 4.6.

3.4. Leveraging data from ancillary cases

After finishing our data analysis, we decided to augment our single-case study with data from nine additional cases of multidisciplinary ASO teams. The purpose of this additional data collection and analysis was to explore the extent to which our findings were idiosyncratic to the context of the single-case study. The methodology and insights from these ancillary cases can be found as supplementary material to this paper.

4. Findings

Our paper seeks to reveal a process perspective on how academics learn to collaborate with non-academics in the context of ASOs. Observing this process in Foodtech, we identify three consecutive cycles of individual-level learning among the Foodtech academics. In Sections 4.1–4.5, we provide a narrative account of this process, supported by empirical data from Foodtech. Fig. 1 provides an overview and illustration. In Section 4.6, we integrate these first-order observations into an abstract process model, relevant outside the specific Foodtech case.

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[2] We applied Kolb's learning framework in a sensitizing way: to make sense of our data and group our first-order codes into theoretically meaningful categories. In this, we followed established practice in inductive, qualitative work, whereby the author uses a general theory to make sense of data collected about a more specific phenomenon (Eisenhardt et al., 2016). In this approach, the established theory is used to frame and guide interpretation, yet, the researcher allows some leeway from the original theory to allow unintended insights to emerge. For qualitative studies that use an existing theory in this way, see for example Graebner (2009), who use trust theory in a sensitizing way to study acquisition process or Brattström and Faems (2020), who use political theory in a sensitizing way to study alliance dynamics. More specific to learning, Politis (2005) applied Kolb's learning theory in a sensitizing way, arguing that individuals operating in entrepreneurial contexts can face different events which force them to choose different modes to transform experience into knowledge.

Conceptual themes	Case prologue October 2010-March 2012	Learning about the venture April 2012 – July 2012	Learning about the self August 2012 – September 2012	Learning about the team October 2012 – November 2018
1. Perceived scope of responsibility	**Atomistic responsibility:** Non-academic managers responsible for commercial activities, Academics responsible for technology development		**Holistic responsibility:** As non-academic managers leave the team, Academics are forced to take responsibility also for the commercial side of the venture	

Holistic responsibility: As non-academic managers leave the team, Academics are forced to take responsibility also for the commercial side of the venture

1. Perceived scope of responsibility

Atomistic responsibility: Non-academic managers responsible for commercial activities, Academics responsible for technology development

2. Action orientation

Narrow: Non-academic managers develop a business case while Academics focus on technology development

Broad: Academics start to develop a plan-A and plan-B business case while also developing the technology

Extrospective: Academics engage with customers to learn more about the "commercial logic"

Extrospective: Academics deepen their engagement with customers

Extrospective: Academics scout for a new manager who understands the commercial logic

Narrow: Academics refocus their action on technology development (but keep a holistic responsibility)

3. Abstract conceptualization

Path-bound: E. M. and C. see the operations of Foodtech as a natural extension of their scientific work.

Domain comparative: Academics start to contrast what they have done as scientists to what they need to do as entrepreneurial scientists

Intrapersonal: Academics realize that their research based-experience does not enable them to connect "means" (their technology) to "ends" (what customers need)

Intrapersonal: Academics realize that this "different way of thinking" can negative impact their future, scientific work

Interpersonal: Academics see their own fault in the prior collaborative failure

4. Future-oriented reflection

Science-based: E. M. and C. envision a future that builds on the experiences they have gained as successful scientists

Business-based: Academics reflect on how different the commercial operations need to be, compared to their scientific operations

Intrapersonal: Academics. realize that moving from "means" to "ends" requires them to have a multifinal way of thinking

Interpersonal: Academics perceive the need to be more accommodating to different perspectives

Interpersonal: Academics realize that having dual logics in the team will get them closer to "ends" without losing "the means"

5. Cognitive-scripts

Non-awareness of cognitive scripts: Academics do not reflect on the possibility of the science-based logic being less valid in a non-scientific context

Awareness of different cognitive scripts: Academics become aware of different logics other than their own.

Comprehending different cognitive scripts: Academics perceive that the scientific logic is not only different, but might be in conflict with a commercial logic

Bridging different cognitive scripts: Academics understand how to work with a different logic, while they themselves stay true to a scientific logic in technology dev. work

6. Collaborative dynamics

Dysfunctional collaborative dynamics: all team members testify to a malfunctional, conflict-laden collaboration

No non-academics in the team

Functional collaborative dynamics: All team members testify to a well functioning collaboration
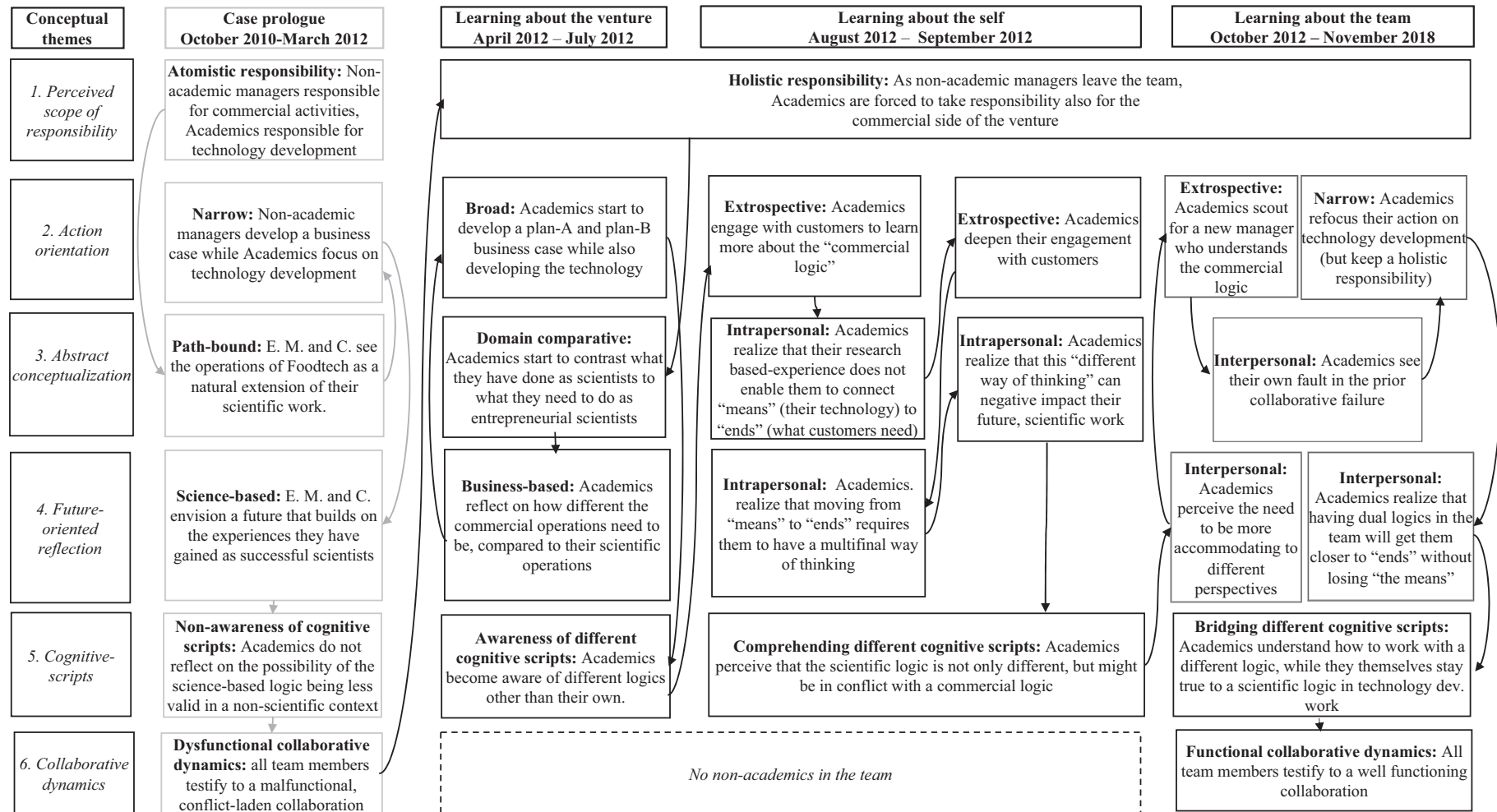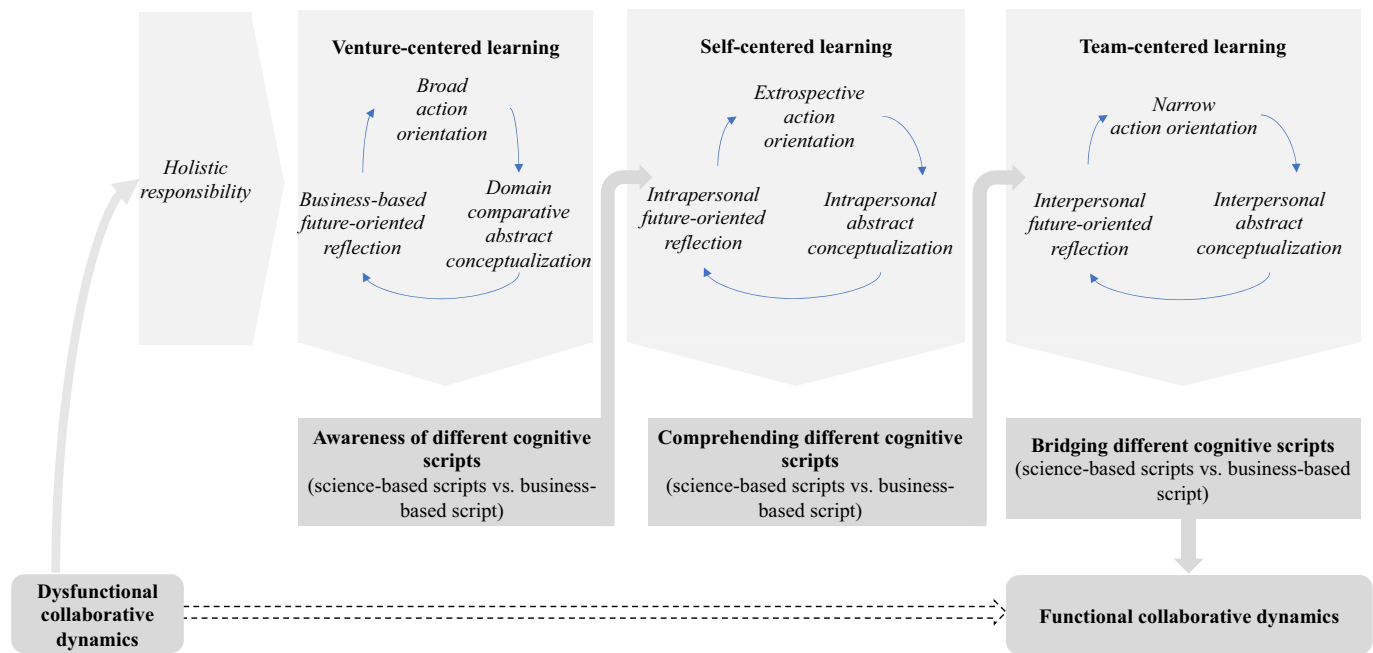
Fig. 1. Visual map.

Fig. 2. A process model of how academics learn to work with non-academic managers.

Finally, we rely on an additional data set of nine case studies to discuss the empirical generalizability of this model (see Appendix).

4.1. Case prologue (October 2010-March 2012)

Elizabeth had been an academic at a prominent institution in Sweden. In 2006, after many years of research, she made a scientific breakthrough. She developed a measurement technique that revealed how blood glucose and insulin production in the human body change with the consumption of different types of bread. Together with two of her fellow academics, Catherin and Marta, Elizabeth concluded that her invention could be of commercial value to the food industry. The main drivers for her starting a venture where her passion for improving people's health through science and the unique technique she had developed, which would allow bread producers to show consumers how different flour-based foods could be processed by the human body. Hence, in October 2010, Elizabeth, Catherin, and Marta (hereafter referred to as "the academics") decided to establish a new venture—Foodtech—to commercialize their results.

4.1.1. Perceived scope of responsibility

At the start of their venture, the academics were concerned that none of them had sufficient commercial experience. Marta and Elizabeth had spent their entire careers as university employees, with little contact with the commercial world. As Elizabeth said, "*We had no business experience whatsoever with this kind of startup.*" Catherin had the experience of working in private-sector laboratories at two multinational companies. However, she considered this experience to be completely unrelated to commercialization: "*I'd been working in companies like Nestlé and ABB, and my work had always remained in the research domain.*"

To gain some commercial understanding, the academics decided to join a venture incubation program at one of Sweden's well-regarded food-based science parks. The incubator recommended that the academics complement their team with non-academic managers, who could help them commercialize their invention. The incubator's CEO suggested two business people, Leif and Oloff ("the managers"), as suitable candidates who joined the Foodtech team in 2010. Even though the academics had no prior relationship with Leif and Oloff and were not required by the incubator to invite them into the team, they were very

enthusiastic about the opportunity to get fresh insights from team members with complementary skills and competencies:

> We knew from the beginning that we had different ideas on what and how the technology would look like and how it should be used… We invited these people believing that it could be useful for us to realize the idea… These people come with different competencies and different knowledge and networks, and they could be useful for us to realize what we were supposed to do. (Elizabeth, academic)

After Leif and Oloff joined the team, the academics felt relieved that they could take a step back from commercialization activities. Leaving commercialization in the hands of Leif and Oloff, the academics instead focused on technological development—improving the validity of the measurement technique—which they considered to be their primary responsibility. Conceptually, we refer to this as *atomistic responsibility*: a perception of responsibilities being divided between the business and the technological side of the new venture:

> We felt that someone else had the key responsibility for the business side… I felt that we were contributing with the science part and someone else was going to be more oriented toward the business. (Elizabeth, academic)

4.1.2. Action orientation, abstract conceptualization, and future-oriented reflection

After working on the new venture for six months, the team encountered an unexpected setback: The government imposed a new regulation constraining the extent to which Foodtech could claim and communicate benefits from their measurement technique. Both the academics and the managers felt a sense of urgency, triggered by this event. Yet, they differed in their *abstract conceptualizations* of what needed to be done. The managers interpreted the new regulations as a recommendation, not a rule. They suggested that the team stop working on the measurement techniques, and instead build on existing knowledge to launch a bread product for which they could claim health benefits, as quickly as they could:

> There is a saying: Sometimes it's better to ask for forgiveness than ask for permission! So sometimes we were like, "Why not launch a product and if the government says blah, blah, blah, we could say,

'Oh, we are sorry,'" but just to try if the market is there. (Leif, manager)

The academics saw the priority of developing the knowledge behind the technology. They also saw their engagement with technology development as a natural extension of their prior scientific work. Instead of shifting the focus to product development, they were convinced that Foodtech operations needed to be closely related to continued refinement of the measurement technique:

If we want to be in the company, we are going to produce bread that is supported by science—or, at least, it should be sold according to the regulations, because we should not be another product that misleads the consumer. (Elizabeth, academic)

Even Catherin, who had experience in commercial labs, remained certain: "*I was still convinced that the central innovation of Foodtech was the measurement technique, even after the health claim came.*" In a later interview, she clarified:

I was the one pushing to see if we could use more technical devices to measure food quality, and particularly to see if we could automate food processes. (Catherin, academic)

Based on these different abstract conceptualizations, the academics and the managers decided to further divide responsibilities between them. Leif and Oloff, on the one hand, developed a business case and initiated customer contacts. The academics, on the other hand, focused on technology development. Conceptually, we refer to this clear division of task domains as a *narrow action orientation.*

With such a clear division of responsibilities, the academics and managers grew further apart in their interpretations of what future issues were important. Leif and Oloff stressed the importance of speeding up commercialization processes, perceiving a promising, emergent market for science-based food. Elizabeth, Catherin, and Marta insisted that unless their technique was scientifically proven—in line with government regulations—it was impossible to move forward. They believed that scientific legitimacy was critical and they were motivated by the originality and integrity of their scientific discovery. In their view, conforming to rules was in line with the norms of science and the reward structure of the university. Conceptually, we see these differences in perceptions about what future issues were important as differences in *future-oriented reflection.* Leif and Oloff had a business-based future-oriented reflection, whereas the scientists had a science-based future-oriented reflection:

We tried to maintain our legitimacy among our colleagues at the university, who are also working in this field. (Catherin, academic)

4.1.3. Cognitive scripts and collaborative dynamics

In this situation of atomistic responsibility, narrow action orientation, and different future-oriented reflections, we observe how the academics and the managers grew further apart. Leif and Oloff were deeply frustrated with the academics' inability to understand that the commercial world was different from the scientific world. In a commercial setting, Leif and Oloff reasoned, it is important to operate a sound business model. This, in turn, could imply sacrificing the optimal technical solution to create a product that meets customer needs. The academics were trained in scientific logic. They considered staying true to data, maintaining scientific credibility, and generating the best possible technology as the core rule of operation. As illustrated by the quotes below, both managers and academics testified that the academics were completely unaware of the misfit of this scientific logic in a business context. Conceptually, we refer to this as a *non-awareness of different cognitive scripts:*

We wanted them to work out a business model. But they were avoiding that, and instead, they were running off to different places and trying to improve their technique, and they didn't understand that customer needs are more important. (Leif, manager)

Those people were so proud because they had their academic world, and I lost confidence when I saw that they just, how should I say, they spoilt the business idea because they wanted to have their names in literature instead of earning money because they didn't understand what they were doing. (Oloff, manager)

Those gentlemen [i.e., the non-academic managers] were not really receptive to our discussions… We find it strange that they read the documents so badly, and that they did not perceive that the measurement technique needs validation before it can be offered. (Email from Catherin to Elizabeth and Marta on Feb 2, 2012)

As a result of this unawareness of different cognitive scripts, subgroups emerged leading to increasingly *dysfunctional* collaborative dynamics between Foodtech academics and managers. From March 2011, we observe an increase in conflict between these two subgroups, resulting in growing animosity and frustration. Instead of the multidisciplinary setting bringing benefits to the team, it opened up a fault line that substantially hampered collaboration:

[The] academics were a bit like a squirrel going round in circles. … They were so rigid in their own contacts … That was annoying to me, because I really thought that we really could do something here. (Oloff, manager)

We didn't accept circumventing the regulations…we have been quite firm [about] staying within the framework of the law [because] otherwise I don't feel we have role… I only want to be part of it if it's serious and based on research. (Elizabeth, academic)

In sum, our case prologue describes a situation of atomistic responsibility, where academics and managers assumed responsibility for different aspects of Foodtech (scientific vs. commercial development). In this situation, two separate subgroups emerged (Tajfel et al., 1979). These subgroups were unaware of the differences in cognitive scripts between them, resulting in a dysfunctional collaborative dynamic. To answer our research question—how academics can learn to overcome dysfunctional collaborative dynamics—we now turn to our insights around the three learning cycles observed in Foodtech.

4.2. Phase 1: Learning about the venture (April–July 2012)

4.2.1. Perceived scope of responsibility

In late March 2012, Leif and Oloff decided to leave the team as a consequence of the dysfunctional collaborative dynamics that had emerged. For the academics, this change in team composition implied a major shift in their perceived scope of responsibility. While the managers were still in post, the academics had focused on the scientific side of Foodtech. Their main responsibility had been to guarantee that the measurement technique was valid and accurate, and they had left it to the managers to consider Foodtech's commercial prospects. Seeing their role as that of inventors, academics saw little need to learn about the business and remained with the technical part of the venture. With the managers gone, the academics were forced to engage fully with the commercial side of the venture. Conceptually, we refer to this as a shift from a perception of atomistic responsibility to a *perception of holistic responsibility:*

When the managers left, I saw a shift in responsibility in the group… Moving from the technology, we were forced to go to the product. (Elizabeth, academic)

4.2.2. Action orientation, abstract conceptualization, and future-oriented reflection

Feeling holistically responsible, academics started to contrast their

current area of work—developing a business—with their prior area of work—science. Whereas they had previously seen Foodtech as a natural extension of their scientific work, they now compared the areas focusing on understanding the differences. Conceptually, we refer to this analysis as a *domain-comparative abstract conceptualization*. In interviews, the academics described the nuances of this change:

> This [shift] was obviously subtle… We became disappointed that we could not synchronize the different elements [the scientific and commercial sides of the business] to help it move forward. (Elizabeth, academic)

Based on this comparative conceptualization, the academics started to see the future of their operations in a different light. In the past, they had seen the future as entirely linked to them perfecting the measurement technique. Now, they came to realize that the future of Foodtech depended on whether they could develop a business case out of their invention. Conceptually, we refer to this as a *business-based future-oriented reflection*. This change was evident in the internal memos and meeting protocols that we analyzed. For example:

> We are at a stage where the future of Foodtech depends entirely on whether we employ a market-oriented approach. (E-mail, July 2012)

To get a grip on the situation, the academics took action. In the past, they had focused their action entirely on technological development—but now, they *broadened their action orientation*. While they had previously focused on licensing out their measurement technique to external bread producers, in July 2012, they started to sketch a business case around producing their bread. They described this new business case as driven by the need to generate money quickly:

> We devoted time to building a business case around the idea of launching our own bread… we needed have to have a Plan B so we didn't lose pace, because we couldn't finance our business in any other way. (Elizabeth, academic)

In sum, the first phase of our case was triggered by the managers leaving the team, leading Foodtech academics to assume a *holistic responsibility*, meaning that they saw themselves as personally responsible both for the scientific and commercial sides of the venture. As described above, this activated a learning cycle, encompassing *domain-comparative abstract conceptualization, business-based future-oriented reflection,* and *broad action orientation*. Through these learning mechanisms (Kolb, 1984), the Foodtech academics gained more knowledge about their venture—whereas, in the previous period, they had primarily centered their learning on the technology they had developed (i.e., the measurement technique).

4.2.3. Cognitive scripts

In interviews, the academics described how this learning about the venture caused increasing frustration. They started to grasp how the commercial world operated according to a different logic than the scientific world, in which they had been trained. For example, they were frustrated by customers being more attentive to the business side of things, and hence paying less attention to the state-of-the-art technology. Moreover, having previously succeeded in obtaining research grants to finance their science, they were aggrieved that despite all their efforts, securing investment for Foodtech was difficult. Conceptually, we refer to this emergent awareness of the business world being guided by a different logic as becoming *aware of different cognitive scripts*—even though the academics did not yet fully understand what these differences were:

> Our frustration came from trying to work out where the market was, and why people wouldn't come and buy from us… We were frustrated that as researchers we were used to searching for project money, and we had been spending much time searching for money, but we couldn't get it from the market. (Catherin, academic)

4.3. Phase 2: learning about themselves (August–September 2012)

4.3.1. Action orientation, abstract conceptualization, and future-oriented reflection

Feeling frustrated in the face of a business logic that they did not fully understand, yet still maintaining a holistic sense of responsibility, the academics started to take *extrospective action*. This means that in addition to focusing on their internal operations (technology development and business-case scenarios), they now started to engage with the external world: their potential customers, such as bakeries and other industry players. We found manifestations of extrospective action in both board-meeting protocols and emails:

> It's important to our success that we can find a solution to the challenges we face. We should communicate with customers to understand the validity of what we want to offer. (Board-meeting protocol)

> It is necessary to update our previous market research to gain more knowledge about Foodtech's intended customers, looking at their needs today and in the near future. When developing ingredients, we needed to find the optimum way to bake this product (Email, August 2012)

> It is now time to devote our efforts to building a business case around the idea of launching our own bread (Email, August 2012)

As a result of these customer interactions, the academics decided to abandon their prior focus on perfecting the measurement technique. Instead, they decided to develop their bread-based products—much as the managers Leif and Oloff had suggested earlier. This shift became clear in the board meeting minutes from August 2012. In earlier meetings, the academics focused on problem-solving related to the measurement technique and its validity. Minutes from August 2012, however, indicated a more explorative, open-ended search process in which customer input, rather than scientific proof, would be their guide. When trying to make sense of these extrospective interactions, the academics came to some new realizations. As they now explored new ways of connecting ends (customer needs) to means (the measurement technique they had developed), they saw that the scientific knowledge they had developed in the past would not enable them to realize the commercial ends they were aiming for. Conceptually, we refer to this as *intrapersonal abstract conceptualizations,* where the academics' sensemaking about their situation was closely related to their sensemaking about themselves:

> We realize that [our] current knowledge is not enough, [and] thus there is a need to draw on experience and knowledge from the industry, including customers—mainly knowledge about how to earn money from Foodtech's target [consumer] group, and how to access opportunities. (Board meeting, August 2012)

Based on these realizations, the academics again engaged in *extrospective action orientation,* initiating a new round of customer interactions. For example, in September 2012, they sought to build in-depth partnerships with ingredient suppliers and bakeries with the aim of co-creating a formula that would allow Foodtech to supply bakeries with bread that was healthy, tasty, and affordable. The goal was to gather as much information as possible:

> We were in contact with so many companies. There was one, for example, in Stockholm, a gluten-free baker that we were in advanced contact with, so we worked together; they worked out the procedures for our production. We also cooperated with a starch factory in Kristianstad, where we could create blends and use their equipment. (Elizabeth, academic)

In interviews, the academics described these interactions as a humbling experience. They gradually realized that for them to go from means to ends, merely gathering additional information was not enough. To move

forward, they needed to develop a multifinal way of thinking about business opportunities; one that would be different from the one they had been attached to in the past. Conceptually, we refer to this as *intrapersonal future-oriented reflection:*

> I wanted to hold more of a discussion with these people [customers] to understand their needs and how they saw the future of healthy products—I mean to try, in that sense, to align expectations. And this demanded that I become less fixated on the measurement technique and my initial scientific thoughts around it. (Elizabeth, academic)

At the same time, it was clear that this intrapersonal future reflection triggered a new round of *intrapersonal abstract conceptualization*, as the scientists tried to make sense of their two worlds: the worlds of science and business. They were concerned about how their new way of working would be received by their scientific peers in the future, and they feared that they would lose some of their scientific credibility in the process of developing Foodtech:

> It is challenging to balance being a researcher with pursuing a venture. Mostly from a credibility point of view, it has been a lot of that […] I am one of the first in our department to start a company, and it is quite sensitive in many ways—you know, keeping a foot in both camps. (Elizabeth, academic)

In sum, the second phase of our case was triggered by the awareness of cognitive scripts that had emerged in the first phase. This awareness triggered a new learning cycle (Kolb, 1984), this time characterized by *extrospective action orientation, intrapersonal abstract conceptualization,* and *intrapersonal future-oriented reflection.* Through these learning mechanisms, the Foodtech academics became more knowledgeable about themselves.

4.3.2. Cognitive scripts

Learning about "the self" had implications for the academics' cognitive orientations. They described this learning as a process in which they realized that science was primarily about finding the optimal and "right" way of doing things. In contrast, they acknowledged that entrepreneurship was more flexible, demanding a multifinal way of thinking where several "right" answers could coexist when connecting means to ends. At the same time, they were also worried about how this logic would impact their scientific credibility. They explained this realization to us as balancing two separate worlds: science and business. Conceptually, we refer to these more precise realizations of how the entrepreneurial logic differed from the scientific logic as the Foodtech academics being able to *comprehend different cognitive scripts:*

> For me, I tried to be a bit neutral towards my colleagues at the university who are also working in this field. That was important in the transition for me when we left the measurement technique and moved to sell ingredients and bread. I was trying to balance a little bit what I need to be doing as a researcher and what has to be done at this stage of our venture. (Elizabeth, academic)

The academics also emphasized that grasping these two logics was not something they had considered before. As such, they described their experience on the market as a humbling one, which had helped them to address their initial lack of commercial experience:

> We did not know how to think about all this [before]. I think we were naïve about that, and we did not reflect on things at the time. (Catherin, academic)

4.4. Phase 3: Learning about the team (October 2012 – November 2018)

4.4.1. Action orientation, abstract conceptualization, and future-oriented reflection

Having learned about themselves and started to comprehend the logic of the science vs. business in Phase 2, the Foodtech academics

engaged in further rounds of future-oriented reflection. However, the focus of this reflection was not only on themselves but also on their interactions with others. Conceptually, we refer to this as *interpersonal future-oriented reflection.* Elizabeth described it as a process of maturation, in which she became more accommodating to others:

> I think we became more open to other contributions, the group, the team… At an early stage, we were very focused as we came from a very clear plan and we were pursuing that—and then, oops! It was not possible, and then I felt we had to be more accommodating… I myself have matured a lot during this process. (Elizabeth, academic)

Based on this new understanding of the venture and themselves, the Foodtech academics turned to *extrospective action* once more—this time by scouting for a team member who could complement their team with a better understanding of the commercial logic. In September 2012, they applied for and secured external funding to hire a new CEO.[3] Having secured funds, the academics were able to hire a new businessperson: Tobias.[4] He was around the same age as Leif and Oloff and had similar business experience in the bread industry. Initially, Tobias was hired as an external consultant in October 2012; he was formally appointed to the role of CEO one month later. Unlike Leif and Oloff, he was paid in salary rather than equity, which he decided not to take for personal reasons. When describing the hiring process, the academics emphasized the benefits of having comprehended different cognitive scripts. They described this as an implicit and emergent process that had made them realize more precisely what competencies they needed:

> When we moved into these other phases, we had learned a lot. Whether we knew it or not. Or whether we reflected upon things or not… [When searching for a new team member,] we were thinking more specifically about what we needed. (Elizabeth, academic)

Working with Tobias triggered new sensemaking processes for academics. In particular, when they compared the current collaboration with Tobias to the earlier one with Leif and Oloff, they started to see their fault in the collaborative problems that had emerged: *"If we had known back then what we know now, we would probably have been able to collaborate well with Leif and Oloff."* Thus, the academics suggested that the past conflicts had not been driven by interpersonal differences, but by their inability to understand the logic of the business world, which the managers pursued. Conceptually, we refer to this as an *interpersonal abstract conceptualization:*

> *Everything was new to us when they [Leif and Oloff] came in, and Leif was the driver, pushing, pushing, and pushing, so I guess this could have worked much better if we had had a similar mindset to the one we have now. (Elizabeth, academic).*

Working with Tobias and realizing their part in the prior conflicts, the academics went back to a *narrower action orientation.* They trusted Tobias to focus on business development, while they focused on technological development. Reflecting on this division of responsibilities, the academics emphasized how it strengthened their team: being able to get to the ends (a bakery product) without losing track of the means (a science-based invention). Conceptually, we refer to this as *interpersonal future-oriented reflection.* As Tobias said:

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[3] Later, in June 2013, the manager of the investment fund, Carmen, was invited to sit on the Foodtech board.

[4] Tobias had industry-specific experience, which Leif and Oloff lacked. Unlike Leif and Oloff, who were paid in equity, Tobias was paid a salary. All three entrepreneurs lacked experience working with academics. We checked whether these aspects had shaped collaboration dynamics and cognitive orientation. Not once, however, they were mentioned as significant. Instead, our informants consistently emphasized that the improvement in collaborative dynamics happened because of changes in cognitive orientation among the three academics - not because of differences in industry, power, and experience among the non-academic managers.

Together with the original group of researchers, I developed a common understanding and a way to communicate and integrate information. (Tobias, manager)

From a team perspective, we learned to enjoy putting people together, people with really different competencies… It is just a fascinating way of communicating, where you can contribute with your two viewpoints. (Elizabeth, academic)

In sum, the third phase of our case was triggered by the comprehension of different cognitive scripts, which was the core outcome of the second phase. This comprehension triggered a third learning cycle (Kolb, 1984), characterized by a *narrow action orientation, interpersonal abstract conceptualization,* and *interpersonal future-oriented reflection.* Through these learning mechanisms, the academics became more knowledgeable about the functioning of their team.

4.4.2. Cognitive scripts and collaborative dynamics

The academics' learning about their team had implications for their cognitive orientation. In particular, they described how they could now *bridge different cognitive scripts,* meaning that they now could make their pre-existing scripts work in harmony with those of other team members. The academics did not change their way of thinking but instead found a way to let their science-based logic function in tandem with a more business-oriented logic. They now saw themselves acting as "helicopters"—that is, having an overview, while staying "true" to science themselves:

I really think that maybe when Leif and Oloff were there, we were representing the different parts [business and science], and we lacked someone who could act like a helicopter [reconciling both]. We started becoming that [helicopter] ourselves along the line when Leif and Oloff left Foodtech. (Catherin, academic)

Thus, in many ways, Foodtech in the fall of 2012 resembled the time when the prior managers—Leif and Oloff—had been in place. The team was composed of three women with a solid scientific background, focusing on technological development, and a newly recruited, male CEO, focusing on business development. Unlike before, however, the collaborative dynamics between academics and managers were now productive and well-functioning. When explaining these differences, the academics referred to the important transformation that they had undergone. In particular, they made it very clear that the problems with earlier collaborations were not because of interpersonal differences; on the contrary, they acknowledged that Tobias was working in a very similar way to Leif and Oloff. Moreover, they emphasized that had Leif and Oloff joined the team at this point, the collaboration would probably have worked out productively:

We had nothing against Leif or Oloff, but we have always been driven about the content. (Elizabeth, academic)

While Tobias was a very different person in character, he had a very similar mission to Leif and Oloff. (Marta, academic)

Instead, they saw their maturation—*the ability to bridge different cognitive scripts*—as the core explanation for the fruitful collaboration:

Apparently, we were not ready to take on these ideas at that time. But we matured and we are more ready to take things on now… I reached this point where I said, "It is okay to try these other paths." I did not leave my academic thinking behind, but I became more accommodating to other ideas. (Elizabeth, academic)

4.5. Epilogue

From fall 2012 onward, Foodtech's members made important developments to their product. For instance, they created different product mixes that suited different sorts of bread, including frozen bread, crispbread, and hamburger buns. While the academics aimed to stop relying on external funds and instead generate income from selling bread, this required more time, which affected their ability to retain Tobias, whose salary was expensive for the firm. Therefore, Tobias had to leave Foodtech in 2014 due to a lack of funds. He was replaced by Christopher, who joined the company as CEO the same year. Despite his experience in commercializing technology, Christopher was younger and less experienced than Tobias. Therefore, he accepted a lower salary, which was convenient for the academics to sustain a positive cash flow. Like Tobias, Christopher had no prior experience in founding ventures together with scientists. When we stopped following Foodtech in November 2018, all Foodtech members emphasized the functional collaborative dynamics in the team. Moreover, they considered the venture as having a strong commercial orientation, while still being grounded in science.

4.6. Bridging cognitive scripts in multidisciplinary ASO teams: a process model

Based on our observations reported in the prior sections, we developed a process model demonstrating how academics can learn to work with non-academic managers when seeking to commercialize their scientific inventions in the form of a new venture. This model is illustrated in Fig. 2. This model encompasses three specific learning phases. In the first learning phase, academics learn about the *venture,* resulting in the *awareness of different cognitive scripts.* In the second learning phase, they learn about *themselves,* giving them the ability to *comprehend different cognitive scripts.* Finally, in the third learning phase, they learn about their *team,* resulting in the ability to *bridge different cognitive scripts*—an ability that we found to be crucial for functional collaborative dynamics to occur.

To theoretically frame how learning occurred within each of these three phases, we leveraged our observations in conjunction with Kolb's learning theory. Kolb (1984) depicts learning as a cyclical process, in which individuals grasp experiences and transform them into knowledge. Building on these general insights, our process model encompasses three learning mechanisms: *action orientation, abstract conceptualization,* and *future-oriented reflection.* While these mechanisms occur within each of the three phases, the object of these mechanisms changes from (i) the venture to (ii) the self and then to (iii) the team. In the following, we elaborate on this process in detail, linking our empirical observations to generalizable, theoretical insights.

4.6.1. Holistic responsibility as the trigger for learning

Our case observations reveal holistic responsibility—i.e., a perception of being accountable for the commercial as well as the scientific side of the venture—as an important triggering condition for learning to occur. In our specific case, this holistic responsibility was forced upon the Foodtech academics, as the non-academic managers decided to leave the team. Thus, the academics had no choice but to assume responsibility for commercial development—a domain that they had previously seen as attached to the managers. In other cases, however, we expect that academics could also assume holistic responsibility without being forced to do so.[5]

4.6.2. Phase 1: Venture-centered learning and awareness of different cognitive scripts

During the early phase of Foodtech's development, academics had primarily focused on their scientific invention, consistent with the conventions held by their scholarly community. However, on assuming a holistic responsibility, their focus changed, and they started to see

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[5] In the supplementary material to this study, we provide data from ancillary cases that show how holistic responsibility can be manifested differently in different cases.

science and business as two inseparable tasks that must coexist. In our findings, we describe how this triggered three mechanisms through which academics learned about their venture: (i) *broad action orientation* (initiating a plan-A and plan-B business case together with developing the technology)*; (ii) business-based future-oriented reflection* (reflections on how different the commercial operations needed to be, compared to the scientific operations); and (iii) *domain-comparative abstract conceptualization* (contrasting their work as academics to what they needed to do when engaging in entrepreneurship). As Kolb (1984) emphasizes in his learning theory, individual-level learning tends to shape people's cognitive scripts. This aligns with our observations. As the academics learned about their venture, they also started to realize how little they understood about the logic of the commercial world. As described in the findings, they became frustrated with themselves for being unable to align the two different parts of the venture: the scientific part, which they saw as being based on data and rigorous analysis, and the commercial part, which seemed more irrational and ambiguous to them. Conceptually, we frame this as the academics becoming *aware of different cognitive scripts*.

4.6.3. Phase 2: self-centered learning and comprehension of different cognitive scripts

In Foodtech, the awareness of different cognitive scripts triggered the second phase of learning, this time oriented towards the academics themselves. Through *extrospective action,* the academics sought external input from bakeries and suppliers; through *intrapersonal abstract conceptualization*, they made sense of their extrospective action. This means that they came to understand that their scientific approach would not enable them to connect means (their technology) to ends (what customers need). Finally, through *intrapersonal future-oriented reflection* the academics reflected on the way forward and understood that going from means to ends would imply not merely acquiring more information, but developing a whole new way of thinking. As the core outcome of this learning cycle, they started to *comprehend different cognitive scripts.* This implied a more precise realization of how the scientific and the commercial logics differed. Moreover, it implied a realization that by following customer needs (as stipulated by the commercial logic), they might have to compromise the ideals of the scientific logic.

4.6.4. Phase 3: team-centered learning, bridging cognitive scripts, and functional collaboration

As the academics started to fully comprehend the content of the commercial and scientific scripts, they also started to see the team in a different light. Thus, *team-centered learning* took place. *Interpersonal future-oriented reflection* showed the academics that to move forward, they needed to accommodate different perspectives. *Interpersonal abstract conceptualization* allowed the academics to see how the failure of the prior collaboration had been partly their fault. Based on this realization, they hired Tobias, a new non-academic manager. This allowed the academics to return to a *narrow action orientation,* meaning that they focused on technological development once again, leaving commercial development in the hands of Tobias.

Even though the academics narrowed their action orientation, it is important to emphasize that they maintained the perception of holistic responsibility. Thus, while they divided *tasks* between them, leveraging their strengths as academics and Tobias's strength as a commercial expert, they did not step away from commercial responsibility. Being holistically responsible, albeit with a particular focus on a narrow task domain, Catherin, Marta, and Elizabeth were able to put their own, scientific logic to work in tandem with the business logic of Tobias. Conceptually, we refer to this as an ability to *bridge different cognitive scripts.* Building on this capacity, the collaboration between the academics and the non-academic manager thrived, realizing the full potential of their ASO team.

It is worth noting that the contrast between the functional collaboration with Tobias and the dysfunctional collaboration with Leif and

Oloff was not due to the managers' respective personalities, but rather the academics' inability to comprehend the different cognitive scripts. For instance, the academics emphasized that their past relationship with Leif and Oloff was on a par with the relationship they now had with Tobias. They confirmed that their relationships with Leif and Oloff was friendly and professional, suggesting that they had no issues at the personal level:

> Catherin, Marta, and I often traveled by train to Kristianstad and Oloff and Leif sometimes picked us up at the station. We also had lunches together, adjacent to our meetings. We had no problems getting along with either of them as such. Both of them were happy to talk about their deeds, so we were probably doing a lot of listening to them while socializing. (Elizabeth, academic)

Moreover, Catherin explained that while they had not known Tobias or Leif before their collaboration, they had known Oloff. While the prior acquaintance with Oloff made it easier to communicate with him and brought the relationship even closer, they still did not manage to build up functional collaborative dynamics with him. Moreover, Catherin attributed their ability to bridge different cognitive scripts to learning and maturing along the way:

> We knew Oloff; he was working as a managing director in the food sector, and he was on the board of the science park... We did not have any encounters with Tobias, nor did we with Leif, so it was an equal relationship, more or less. Tobias came at a later stage in the company, and in that phase, we matured. In the beginning, we were naïve. (Catherin, academic)

5. Discussion and implications

As its primary contribution, this study shows how academics can better collaborate with non-academic managers in the context of multidisciplinary ASO teams by learning to *bridge different cognitive scripts,* meaning that they develop an ability to let their pre-existing scripts work in tandem with those of other team members. Based on rich, longitudinal data from a single case, we advance a three-phase process model, showing both the triggering conditions and underlying mechanisms through which such learning unfolds.

Due to their different training and backgrounds, academics and non-academic managers often possess different cognitive scripts, which contribute different skills, knowledge, understandings, and viewpoints when working together in the context of an ASO. Such differences can be a core strength for the ASO, given that the successful management of an ASO typically requires an in-depth understanding of science as well as the commercial world (Storey and Tether, 1998; Vanaelst et al., 2006; Vohora et al., 2004). However, in some cases, different cognitive scripts may lead to dysfunctional collaborative dynamics, where team members gravitate towards categorizing themselves into distinct social groups 'us' versus 'them', which impacts negatively on their venture's performance (Ben-Hafaïedh et al., 2018; Clarysse et al., 2005; Diánez-González and Camelo-Ordaz, 2016). While prior research has acknowledged this challenge, our study is among the first to offer theoretical insights into how it can be overcome.

5.1. Towards a developmental understanding of collaboration in multidisciplinary ASO teams

As a core contribution, our emergent framework offers a developmental perspective on how to bridge the cognitive distance, thus benefiting from cognitive differences in a multidisciplinary team instead of limiting them. This developmental approach differs from prior research, where scholars have suggested that multidisciplinary ASO teams should be set up in a way that ensures cognitive overlap. Either from the start if academics already have some commercial experience (Ben-Hafaïedh et al., 2018; Diánez-González and Camelo-Ordaz, 2016;

Nooteboom et al., 2007). Or, that non-academic managers are invited only after some time, after the academics have gained commercial experience. However, the idea that those academics who have or make commercial experiences will also build better multidisciplinary teams does not address the process through which academics can learn to work together with non-academic managers, including failed attempts and the conditions and mechanisms underlying learning. Neither does it clarify how academics who desire to team up with non-academic managers, but lack a prior understanding of the commercial world, can learn to commercialize their scientific innovations in collaboration with others. Most importantly, ensuring cognitive overlap undermines the very purpose of a multidisciplinary team, which is to benefit from broad experience rather than narrowing it down.

Our analysis thus offers an important extension of prior research on multidisciplinary ASO teams by providing a process perspective that reveals *how* academics can learn to bridge different cognitive scripts when working together with non-academic managers in the context of multidisciplinary ASO teams. We depict this as a stepwise process that starts with the *awareness* of different cognitive scripts, followed by the *comprehension* of such scripts, before finally, a *bridging* between scripts takes place. Each phase in this process requires learning about different objects—the venture, the self, and the team—and encompasses particular mechanisms through which academics take action, make sense of that action, and reflect on how to move forward. In this way, our results suggest that multidisciplinary ASO teams do not necessarily need to have an optimal configuration of team members right from the start. Instead, our findings point to a more versatile capacity of academics to learn how to bridge cognitive scripts, irrespective of their initial distance. This developmental view on cognitive distance in multidisciplinary spinoff teams is particularly important because it is relevant to many academics with startup ambitions—not only those who have an a priori understanding of the commercial world.

5.2. Holistic responsibility enabling academics to share power with non-academic managers

As a second contribution, we propose the notion of *holistic responsibility* and point to it as an important situational condition for functional collaborative dynamics in multidisciplinary ASO teams. By "holistic responsibility," we mean a perception among academics that they are personally responsible for the venture's scientific and commercial development. We show how holistic responsibility triggers the learning process enabling academics to bridge cognitive scripts. Moreover, we also demonstrate that after the ability to bridge scripts is attained, holistic responsibility enables a clear division of tasks (whereby academics carry out the science and non-academic managers carry out the business) without compromising ASO team members' abilities to coordinate between tasks.

Prior work has suggested that academics are often unwilling to give up managerial power in the early phases of their venture, and that non-academic managers should therefore enter at a later stage of the venture's development (Guo et al., 2019; Nikiforou et al., 2018). Our findings, however, show that even in cases where academics *willingly* give up power and assume an atomistic rather than holistic responsibility, such a division of responsibilities may trigger dysfunctional collaborative dynamics. Therefore, a core implication of our research is that academics should maintain holistic responsibilities, even if they decide to invite non-academic managers to carry on heavy task duties and assume decision-making power. With holistic responsibility, the ASO can benefit from the different capacities stemming from the different expertise of academic and non-academic members.

This analysis is also crucial to researching the timing of integrating non-academic managers into the ASO because it helps resolve contradictions between two opposing arguments. Some scholars argue that the early introduction of managers leads to a shorter time to market (Rasmussen et al., 2011; Vohora et al., 2004), whereas others suggest that academics are better off relying on external advisers until they gain a better understanding of how managers could help their venture (Guo et al., 2019; Nikiforou et al., 2018). We complement these contrasting views by showing that the successful integration of managers is not necessarily related to the phase at which they are introduced, but whether academics can assume a holistic responsibility for the venture. In this way, we move beyond conceiving the discussion on integrating non-academic managers as a matter of timing into a discussion on the triggers and dynamics through which academics learn to work with non-academic managers.

5.3. Contributions to Kolb's theory of learning

Although Kolb's theory of learning was not initially a part of our theoretical framework, we relied on it in a sensitizing way, and it turned out to be helpful in our interpretation of the data. By applying this general model to the specific context in which academics in ASO teams learn to work with non-academic managers, we provide an operationalization of this model that can be of use to future research on learning in ASOs. To start, whereas Kolb's (1984) general model does not stipulate what individuals learn about, we show that in the specific context of ASO teams, it can be important to understand whether the object of learning is the venture, the team, or the individual learners themselves. In particular, we show that learning about these different objects also entails specific versions of Kolb's more general learning mechanisms. For instance, when academics shift the focus of their learning from the venture to the individual, they move from *broad action orientation* to *extrospective action orientation*. Similarly, when they refocus their learning from the self to the team, they transition from *interpersonal abstract conceptualization* to *intrapersonal abstract conceptualization*. In this way, our model both highlights the usefulness of Kolb's general framework and provides novel insights into how it can be operationalized in the context of ASO teams.

6. Managerial implications

For academics, founding a new venture demands knowledge about venture-related skills, such as product development or market validation. Since this knowledge does not necessarily come with an academic career, it is common for academics to seek non-academic managers for cofounding. What our findings show, however, is that for such a multidisciplinary team to work, academic founders must not step away from commercial activities completely. Instead, by assuming holistic responsibility for both the academic and the commercial sides of the venture, academics can learn to benefit from the heterogeneity in skills and experiences that come from a multidisciplinary team. Moreover, our work demonstrates that starting a new venture can require academics to undertake a personal journey, where they need to reassess, reformulate, and reconsider understandings that they previously took for granted.

For non-academic managers who participate in ASO teams, our findings demonstrate the importance of teamwork. Multidisciplinary ASO teams hold great promise, as they bring together various skills and competencies. However, the Foodtech case shows that these teams will only deliver on this promise if all their members work well together. Our study outlines some critical elements of fruitful collaboration in multidisciplinary ASO teams, such as holistic responsibility and how team members can learn to bridge different cognitive scripts.

For organizations that provide ASO training and support, we point to the importance of facilitating self-centered learning for academics. Such self-centered learning is not common practice in the ASO support programs (Jain et al., 2009; Visintin and Pittino, 2014), but would serve as an important complement to established training in venture-related skills, such as product development or leadership (Clarysse et al., 2011; Shane, 2004). Overall, a core managerial implication of our study is that incorporating self-centered learning enhances academics' ability to transition into the business world.

7. Limitations and alternative explanations

While our single case allowed us to understand processes and mechanisms of how academics can learn to bridge different cognitive scripts to collaborate with non-academic managers in great detail, single case studies might also be connected to idiosyncratic patterns (Eisenhardt, 2021). Therefore, we complemented our single-case study findings with observations from nine additional cases of multidisciplinary ASO teams that were comparable to Foodtech. Information on these teams can be found in the supplementary material to this paper. Findings from these ancillary cases indicate how the core aspects of the Foodtech case are likely to also manifest in other cases—even if those other cases are from a different country (Germany, not Sweden); and of different team compositional characteristics in terms of gender and prior experiences.

When analyzing our data, we also considered several alternative explanations. First, prior research has suggested that gender heterogeneity can trigger dysfunctional collaborative dynamics (Pearsall et al., 2008). In Foodtech, however, the gender composition (female academics; male non-academic) was similar in all relevant periods, suggesting that gender heterogeneity was not the core driver in this case. We also considered if the fact that Leif and Oloff joined the team based on recommendations from the incubator program (and not by the initiative of the academics) could have hampered collaboration. However, it is important to emphasize that academics saw this suggestion as a recommendation—not as a requirement—and highlighted that they "invited" the managers to join the venture (Elizabeth, academic). Along a similar line, we considered if the dysfunctional collaborative dynamics emerged because of social categorization mechanisms, or the grouping of team members into "us" versus "them" (Tajfel, 1978; Turner et al., 1987). This is important since people tend to feel more closely connected to the members of their social group (e.g., "academics") and more distanced from members of other groups (e.g., "managers"). In our case, however, academics did not testify to having changed their self-identification in phase three (when Tobias was present), compared to phase one (when Leif and Olof were present). They also emphasized that they maintained a strong identification with their scientific profession ("*I did not leave my academic thinking behind,*" Elizabeth). Therefore, we do not believe that change in social categorization constitutes a core explanatory process in our case, even though this might be an important aspect to consider in other cases. For example, future research could explore identity formation and re-formation in multidisciplinary ASO teams (Jain et al., 2009; Lam, 2011) as well as if academics' membership in incubation or acceleration programs change the way they self-identify with their academic careers over time.

Finally, the academics only started to learn about commercial logic after the exit of Leif and Oloff. In our case, this departure represented an important critical event that triggered academics' learning by forcing them to assume holistic responsibility for Foodtech. This observation is consistent with the review on academic spinoffs by Mathisen and Rasmussen (2019, p. 1908) that highlights: "Key findings show that the teams broaden their competencies over time, often as a result of critical events that lead to team member entry or exit." Thus, while team member change can be an important driver of learning in ASO teams, also other critical events might be relevant. The cases of additional multidisciplinary ASO teams described in the supplementary materials point towards additional drivers beyond changes in the team, such as prior insights into different cognitive scripts, the team members' learning orientation, working on different venture tasks, the introduction of better team communication, and joint strategy workshops. Future larger-scale quantitative studies could provide more systematic insights into these and other triggers for academics to assume holistic responsibility for their venture.

8. Conclusion

Prior research has highlighted that multidisciplinary ASO teams often suffer from dysfunctional collaborative dynamics because academics and non-academic managers adhere to different cognitive scripts. As its core contribution, our analysis demonstrates how such dysfunctional collaborations can be overcome. In this way, we advance a developmental perspective on multidisciplinary ASO teams, showing how such teams can learn to realize their full potential.

CRediT authorship contribution statement

Ziad El-Awad (Lead Author): Conceptualisation, formal analysis, validation, resources, writing-original draft, methodology, investigation.

Anna Brattström: Formal analysis, writing original, methodology, conceptualisation, investigation.

Nicola Breugst: Conceptualisation, formal analysis, supervision, writing parts of text.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.respol.2022.104592.

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