Coping with uncertainty: Entrepreneurial sensemaking in regenerative medicine venturing

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Abstract

Entrepreneurs face multiple sources and types of uncertainty during venturing activity. Converting novel or speculative opportunities into viable commercial businesses requires entrepreneurs to address or even leverage uncertainty. This process is especially relevant in nascent, knowledge-intensive fields, where success likely hinges on acquisition and deployment of unique, specialized knowledge resources. Venture development will be partly determined by the sensemaking strategies entrepreneurs employ to cope with irreducible uncertainty, especially as they seek critical collaborations. The regenerative medicine (RM) sector represents a unique context for studying entrepreneurial sensemaking under high levels of uncertainty. We consider how uncertainty in RM venturing affects entrepreneurial behavior. Informed by long-form narrative interviews, we propose a sensemaking model linking uncertainty, university culture, coping and narratives of venture potential in the RM field. This helps explain how participants in the RM sector cope with uncertainty and explore knowledge partnerships. Our findings advance theories of entrepreneurial sensemaking and the impact on nascent entrepreneurial ecosystems.

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1. Introduction

Perceived environmental uncertainty (PEU) places severe limits on entrepreneurial decision-making (Milliken, 1987). When PEU is high, sensemaking helps individuals understand and interpret situations, facilitating action (Maitlis and Christianson, 2014). Sensemaking provides entrepreneurs and managers with a viable narrative (Weick, 1995) that may be communicated to internal and external stakeholders (Cornelissen and Clarke 2010; Lounsbury and Glynn 2001). Technology ventures rely on knowledge exchange mechanisms and collaboration to develop deep capabilities needed to exploit unfamiliar and complex opportunities (George *et al*, 2008; Powell *et al*, 1996).

We study how uncertainty affects entrepreneurial sensemaking through a situational analysis of regenerative medicine (RM) venturing activity. The RM sector represents a useful context for studying entrepreneurial activity under uncertainty. The science of RM, which emphasizes the use of stem cells, is "the process of creating living, functional tissues to repair or replace tissue or organ function lost due to age, disease, damage or congenital defects" (NIH, 2006). RM presents unique challenges to venturing activity. Extremely high levels of irreducible uncertainty have hindered the development of RM venturing, slowing new firm formation and growth (Ledford, 2008). We define irreducible uncertainty as uncertainty that cannot be reduced by information gathering or analysis, and which reflects an unknown but not an unimaginable future (Gloria-Palermo, 1999).

Scientific knowledge requirements, regulatory complexity and research capital intensity has led to a limited number of RM centers of excellence. Scotland (United Kingdom), particularly the capitol city Edinburgh, has a long established history of RM research. The University of Edinburgh houses The Scottish Centre for Regenerative Medicine (SCRM). This is a world-leading RM center, with the advancement of RM research, translation and commercialization at the very core of the organization. Yet despite this, venturing activity has been slow. This provides a unique opportunity to investigate an ecosystem in its formative stages.

Informed by a pilot survey and long-form narrative interviews, we explore how participants make sense of a highly uncertain venturing context. Our research makes three contributions to the study of entrepreneurship under uncertainty. First, we highlight the development of coping strategies during the sensemaking process. We show that RM

individuals differ in their perceptions of PEU and in their coping responses. We discuss the types of coping strategies and the potential implications for venturing behavior.

Second, we extend university-industry scholarship by showing an association between university entrepreneurial culture and entrepreneurial coping strategies. A substantial body of literature exists on the entrepreneurial university (e.g. Etzkowitz, 2000; Etzkowitz, 2003; Rothaermel *et al*, 2007). We extend prior research to propose that coping strategies are tightly linked to entrepreneurial culture at the parent institution. Role-identity conflicts and entrenched hurdles for commercialization activities are more likely to generate coping strategies that hinder collaborative knowledge development.

Finally, we propose a model of sensemaking under irreducible uncertainty. We link uncertainty and parent institutional culture to the development of coping strategies, and ultimately the impact of these coping strategies on collaborative knowledge building and perceptions of venture development potential. The interpretations generated in this sensemaking process have direct and important implications for venture growth strategies and resource assembly activities.

Our study opens new research directions linking entrepreneurial sensemaking to coping strategies and collaborative knowledge development when uncertainty cannot be resolved by information gathering or analysis. Despite important implications for theories of entrepreneurial behavior and venture development, entrepreneurial coping strategies have received relatively little attention. We also build upon recent investigations on selective revealing as an alternative form of entrepreneurial collaboration under uncertainty (Alexy *et al*, 2013).

This paper is organized as follows. Section 2 provides an overview of venturing in the RM field and the nature of uncertainty. It also explores sensemaking under high levels of uncertainty. Methods, data and procedures of this study are discussed in Section 3. We report our research findings in Section 4 and discuss results in Section 5. We offer conclusions in Section 6.

2. Literature

Our research seeks to inform theories of entrepreneurial sensemaking under irreducible uncertainty and the resulting effects on the development of entrepreneurial ecosystems. Focusing on the RM sector presents a useful context for investigating these phenomena.

2.1. Venturing in the regenerative medicine field

RM venturing is difficult and uncertain. The RM industry faces complex political and social forces, uncertain regulatory frameworks, unresolved intellectual property (IP) rights issues, and untested production and distribution systems (Hogle, 2014). The investment and infrastructure requirements of RM commercialization have favored entrepreneurial activities with explicit links to university research programs. Commercialization of university-led stem cell innovations is likely to be dependent upon cultural norms and institutional contexts (Walshok *et al*, 2014; Zahra and Wright, 2011). The dependency on the larger institution may create resource assembly challenges for new technology ventures (Powell *et al*, 1996). These firms must operate with little or no slack in their resource pool, limiting product-market and business model exploration and testing (Bock *et al*, 2012; George, 2005). RM business models remain mostly unproven, evolving through a trial-and-error process (Costa and Levie, 2012; Heirman and Clarysee, 2004; Loch *et al*, 2008). Uncertain business models and the perception of high risk in RM venturing hinders investments by venture capitalists (VCs) and pharmaceutical companies. This has created a knowledge and capabilities gap between RM innovation and commercialization.

Knowledge resources are especially important to new ventures (Grant, 1996; Powel *et al*, 1996). Ventures commercializing novel innovations may compensate for resource scarcity by accessing social networks to legitimize organizational narratives and access knowledge and financial resources (Aldrich and Martinez, 2001; Lounsbury and Glynn, 2001). The sophisticated technological requirements of RM, however, increase these firms' need to explore boundary-spanning resource exchange mechanisms in order to become competitive. In dynamic and complex industries, collaboration and knowledge exchange enable early stage ventures to develop deep and sophisticated capabilities in order to exploit opportunities (George *et al*, 2008). At the same time, technical knowledge increases collaboration costs and uncertainty about partner capabilities and intents. The use of selective revealing to reduce the perceived risk of disclosure may induce the external firm to become more similar to the focal firm with respect to the production of knowledge (Alexy *et al*, 2013).

The RM field has suffered from ethical and legal hurdles that have made public or broad disclosure costly. When high amounts of uncertainty and controversy surround a novel technology, legitimization of this technology becomes essential to resource assembly (Jain and George, 2007). Legitimization of novel technologies is possible through ventures protecting their technology, widely publicizing their technology and influencing key stakeholders (Jain *et al*, 2009). Entrepreneurs in the field of RM have relatively fewer options

for either safely testing legitimizing narratives or exploring collaborative partnerships, without risking the loss of protecting IP.

Venturing in RM will require entrepreneurs to address high levels of irreducible uncertainty. RM entrepreneurs and ventures must rely on risky, costly collaborations and networks to access resources, including knowledge, in order to exploit opportunities. The processes, however, have not been carefully investigated to understand the drivers of such collaboration efforts. As the development of collaboration and knowledge exchange networks are likely important to the formation of the broader ecosystem, studying entrepreneurial cognition in this context offers a window to much larger scale effects under conditions of perceived uncertainty.

2.2. The nature of uncertainty

Venture success depends on entrepreneurs recognizing and responding to uncertainty (McKelvie *et al,* 2011). Perceived uncertainty is generally classified as state, effect or response uncertainty (Milliken, 1987). State uncertainty describes environmental unpredictability. Effect uncertainty represents the inability to predict the impact of environmental change. Response uncertainty limits the ability to predict consequences of choice or action. The appropriate responses to uncertainty lead to growth and firm value (Sirmon *et al*, 2007). Since uncertainty, in contrast to risk, cannot be resolved via data gathering or analysis (Knight, 1933), entrepreneurs cannot manage uncertainty. They can only be prepared for contingencies and cope with living with the unknown.

Coping with uncertainty is a three-staged process. It involves *primary appraisal* in which individuals evaluate the threats to themselves. *Secondary appraisal* considers the response options available in order to deal with these threats. *Coping* with these threats relies on implementing the response options available and involves the use of two coping functions: a *problem-focused* coping and an *emotion-focused* coping (Lazarus and Folkman, 1984). During stressful situations individuals will utilize both types of coping functions in addressing the particular problem. However, problem-focused coping tends to predominate when individuals perceive that they can address the particular situation and emotion-focused coping prevails when the situation is less controllable (Folkman and Lazarus, 1980). These are fundamentally sensemaking choices. Entrepreneurs make sense of uncertainty by either choosing (consciously or unconsciously) to ignore it, or by attempting to solve unsolvable problems.

2.3. Entrepreneurial sensemaking within high uncertainty environments

The cognitive processes of entrepreneurs during venture creation warrant careful study (Forbes, 1999). Prior research has focused primarily on opportunity recognition and decision-making under uncertainty (Haynie *et al*, 2010; McMullen and Shepherd, 2006). Much remains to be investigated, including the unique role of sensemaking, as entrepreneurs explore unfamiliar opportunity sets or create entirely new markets (Grégoire *et al*, 2011).

Organizational research on sensemaking generally emphasizes how individuals make sense of ambiguity and uncertainty within a broader, stable context (Maitlis, 2005; Maitlis and Christianson, 2014; Weick, 1995; Weick *et al*, 2005). Even as scholars examine response to chronic pressure or acute crises (Cornelissen, 2012; Maitlis and Sonenshein, 2010; Weick, 1988; Weick, 1993; Weick and Sutcliffe, 2003), the backdrop of a larger institutional framework provides the overarching norms and expectations of an established organization or industry. Not surprisingly, research has carefully examined how such institutional contexts influence sensemaking processes (Nigam and Ocasio, 2010).

Sensemaking is critical during venture formation, converting the unfamiliar or unknown to the familiar and understandable (Cornelissen and Clarke, 2010; Hill and Levenhagen, 1995). Entrepreneurs observe and interpret data associated with "known unknowns." Deriving choice sets from vague and limited data rationalizes environmental uncertainties, enabling action (Maitlis, 2005). Entrepreneurs use sensemaking to construct stories that legitimize novel ideas (Lounsbury and Glynn, 2001; Martens *et al*, 2007) and generate metaphors to communicate complex or strange innovations (Cornelissen and Clarke, 2010). Entrepreneurs "give sense" to uncertain exogenous contexts to construct new markets (Santos and Eisenhardt, 2009) and find meaning in the wake of failure (Cardon *et al*, 2011).

Prior knowledge is particularly valuable in making sense of environmental uncertainty. Entrepreneurs are likely to rely on their prior knowledge as a cognitive resource, which can allow them to recognize opportunities through identifying structural parallels between new information and a relevant context (Grégoire *et al*, 2010). Prior knowledge, along with learning approaches, has also been shown to be important in entrepreneurial intent to develop and pursue opportunities (Dimov, 2007).

The underlying mechanisms that activate, influence and enable sensemaking are far less well understood. Only recent research has explored the specific cognitive patterns that connect the search for meaning to entrepreneurial behavior. Byrne and Shepherd (2013) found entrepreneurs engaging in coping strategies in order to make sense of business failure. In particular, they found that entrepreneurs with more effective cognitive processing of

business failure reported higher levels of emotion-focused coping. Yet, the role of affect-based patterns in sensemaking are not well-studied in the entrepreneurial literature (Maitlis *et al*, 2013).

Despite a growing body of research on sensemaking, particularly its importance in the study of organizations, research remains fragmented (Maitlis and Christianson, 2014; Sandberg and Tsoukas, 2015). A key purpose of our study is to extend prior research on patterns of sensemaking cognition, especially when PEU is high. We have very little information on how entrepreneurs make sense of the venturing process under conditions of irreducible uncertainty. We expect that institutional factors are likely to shape individual sensemaking (Nigam and Ocasio, 2010; Weber and Glynn, 2006), but we do not know how these effects will present when the new venture is relatively distinct from the prior institutional context. We also want to understand how sensemaking influences entrepreneurial perception of critical functions to the development of the organization, including knowledge collaboration.

3. Data and Methods

3.1. Study context: uncertainty in the RM industry

The United Kingdom (UK) occupies a world leading position in RM research, with stem cell academic centers of excellence located in Edinburgh, Cambridge, London, Oxford and Newcastle.

The UK government is encouraging RM translation in a number of ways. It has invested in RM infrastructure to help firms and healthcare providers exploit the long-term clinical and economic benefits arising from stem cell research (*Taking Stock of Regenerative Medicine in the UK*, 2011). The governmental funded Technology Strategy Board (TSB) agency has established the Cell Therapy Catapult (CT Catapult). This is charged with ensuring that the UK becomes a global leader in the development, delivery and commercialization of RM. Between 2013-2018, the UK government has allocated £70m of core funding to CT Catapult (*BIA*, 2013). The TSB, in conjunction with the Medical Research Council (MRC), has also established a Biomedical Catalyst Translational Funding Programme, which offers funding to SMEs and academics. Furthermore, the TSB has established knowledge transfer networks (KTN). The Health KTN is tasked with accelerating innovation and technology exploitation through knowledge exchange mechanisms. Moreover, the TSB also offers various individual funding programs to support SMEs and

academics in developing solutions for particular healthcare issues. Governmental funding support has also been utilized in order to form the UK RM platform (UKRMP), which seeks to address the technical and scientific challenges facing RM research, and to promote RM translation. Additionally, the National Institute for Health Research (NIHR) is supporting RM to the sum of £9 million a year. Total UK publicly-funded research in RM exceeded £77 million in 2012 (*Regenerative Medicine Report*, 2013).

For stem cell companies and investors, the UK offers a competitive fiscal environment, which includes favorable R&D tax credits, reduced cooperation tax rates and significant non-dilutive grant funding (*BIA*, 2013). At present there are 26 active RM companies in the UK, which is the second highest in Europe behind Germany (*House of Lords Scientific Committee Report*, 2013).

Within the UK, Scotland has a long and well-known history in RM, popularized by the story of Dolly the sheep. Dolly was the first cloned mammal from an adult somatic stem cell (Wilmut *et al*, 1997). Life Science Scotland, a subsidiary of government-run Scottish Enterprise, has focused on encouraging RM collaborations, innovations and translation. Within the Scottish life science ecosystem, several organizations support RM collaborations and translational activities. These include The National Health Service (NHS) Research Scotland, which provides an outlet for multi-center clinical studies, and Health Science Scotland, which assists academia and industry collaborations.

The capital city of Scotland, Edinburgh, is home to The Edinburgh BioQuarter. This is a £600 million joint venture between Scottish Enterprise, The University of Edinburgh and NHS Scotland. The Edinburgh BioQuarter is designed to encourage commercialization at the university-industry boundary. Located at The Edinburgh BioQuarter site is The Scottish Centre for Regenerative Medicine (SCRM), which provides state-of-the-art research facilities to advance stem cell and RM research. Further details relating to the RM ecosystem in Scotland and Edinburgh are shown in Table 1.

Table 1 here

Despite the RM history and infrastructure in Scotland, venturing in this ecosystem remains in a formative stage. The ecosystem is at the forefront of RM research but lags in commercialization. This provides an opportunity to witness early-stage ecosystem development that would otherwise not be possible in more established RM ecosystems such as Boston, San Diego, London or Seoul.

3.2. Data

To explore sensemaking and behavioral processes, we utilize a primarily qualitative approach to better develop insights into socially constructed knowledge and events (Locke, 2001). A small, online pilot survey confirmed the relevance of key constructs, but the primary dataset consists of long-form narrative interviews (McCracken, 1988). Information about the complete set of qualitative informants is provided in Table 2.

Table 2 here

Information on target informants was obtained from The Edinburgh BioQuarter. Informants were selected based on direct involvement in the commercialization of RM in one of the following four categories: 1) RM entrepreneurs, 2) Academic scientists, 3) RM/life science support entities, and 4) RM companies. We excluded for-profit third party support firms such as consultancies. We also excluded full-time students, even those with significant entrepreneurial intent. This ensured efficient and effective saturation of categories, providing sufficient data to account for all aspects of the phenomenon (Morse *et al*, 2002). Informants were not provided detailed information about the interview to prevent prejudicial preparation of information or materials.

3.2.1. Long-form narrative interviews

The lead author conducted face-to-face, long-form narrative interviews with informants between November 2012 and September 2013. Interviews were conducted in private facilities to prevent interruptions and ensure confidentiality. Informants were asked to *"tell the story of their participation in the commercialization of regenerative medicine innovation."* Narrative approaches are particularly useful for theory building in entrepreneurship (Fletcher, 2007; Larty and Hamilton, 2011). Informants were given complete freedom to recount their narrative without interruption and with limited or no further direction. This minimizes investigator bias, increases informant comfort and encourages informants to recount their own story in their own words and focus on self-identified areas of interest. Legal and ethical controversies associated with RM require an especially sensitive approach to the collection of qualitative data. The open-ended, non-directed narrative approach helps to reduce staged responses and social desirability bias (Podsakoff *et al*, 2003). Informants were encouraged to talk until they felt that they had reached a self-determined conclusion. Following the informant-determined end of the main narrative, some informants were prompted to provide

additional details on key areas of interest. Field notes were generated during and immediately after each interview to provide *in situ* interpretation to complement transcript coding. The duration of the interviews ranged from 16 minutes to 111 minutes, with the average length being approximately 60 minutes. The final dataset includes 23 long-form narratives, equating to 151, 192 words of textual data.

3.2.2. Online pilot survey

A small-scale, online pilot survey was utilized to confirm the relevance of key constructs and frame the coding of the narrative interviews. The survey was designed to elicit data on informant's perceptions of RM venturing. Survey questions included both closed and open-ended questions on facilitative and inhibitive factors to RM venturing activity. Question types and order were carefully considered to reduce common method biases (Podsakoff *et al*, 2003). The survey was pre-tested by administration to an RM industry expert and a RM academic scientist to ensure clarity of design and relevance of the questions (Fowler, 2009). Survey informants were selected from the RM informant target list and e-mailed regarding their participation. We invited 26 individuals to participate in the survey and received 15 responses, which represents a 58% success rate. Referrals by first-wave respondents to additional industry participants generated 7 additional responses. Therefore, a total of 22 responses were utilized in the pilot survey analysis.

3.3. Procedures

Analysis of the RM venturing interview narratives was informed by grounded theory (Strauss and Corbin, 1990). The results of the pilot survey were used solely to inform and validate the qualitative coding process. 1st order codes were generated via open-ended coding of the transcripts and triangulated against the results of the pilot survey to identify overlap and gaps. 2nd order groupings of the 1st order codes were identified via a cycle of inductive and deductive reasoning. Finally, the 2nd order groupings were organized into aggregate theoretical dimensions based on reviews of the transcripts and the broader narratives described by the informants. All coding was performed using NVivo software.

4. Findings

We first present the findings of the online pilot survey and then the findings from the narrative interviews.

4.1. Online pilot survey findings

As the pilot survey data was used solely to inform the qualitative interview coding, we report only simple descriptive statistics. Key findings from the pilot survey are presented in Table 3. We note key summary findings that informed the qualitative analysis. First, most respondents agreed that RM venturing is challenging due to entrepreneurial resource constraints. The majority of respondents suggested that collaborations with universities and national-level funders, government entities or national healthcare providers are required to overcome these deficiencies. Most agreed that collaborations enabled knowledge exchange, access to resources and the development of valuable organizational capabilities. There was also agreement that unrealistic commercialization timeframes have been set for RM commercialization. Respondents further noted that commercialization was inhibited by uncertainties surrounding RM regulation, manufacturing, distribution and scale-up. Despite these challenges, most respondents disagreed that RM collaborations were difficult to manage. Most disagreed that collaborations with large pharmaceutical firms were required for RM commercialization. Respondents were split on whether VC funding was reasonably accessible for RM commercialization or whether collaborations were costly and failed to deliver.

The results of the pilot survey clearly confirm some of the challenges of RM venturing, but provide first indications of the sensemaking mechanisms that entrepreneurs use to justify continued venturing activity. We used these results to inform our qualitative coding procedure, as we were particularly interested in the potential for cognitive and sensemaking processes.

Table 3 here

4.2. Narrative interview findings

The results of the interview coding are presented in Table 4, utilizing a multi-level data structure (Walsh and Bartunek, 2011). The first column of the table shows the prevalence (%) of 1st order codes within the total (T) 23 interviews. The table also highlights the prevalence

(%) of 1st order codes for each informant category, which includes interviews with 6 entrepreneurs (E), interviews with 3 academics (A), interviews with 12 support entities (SE) and interviews with 2 RM companies (RC).

Table 4 here

We review the theoretical dimensions revealed by the data and provide illustrative examples of 1st and 2nd order codes to highlight findings, relevance and significance.

Perceived environmental uncertainty (PEU). Our data shows high levels of PEU surrounding RM venturing. Informants consistently reported high levels of funding uncertainties: *"Yeah, if you can imagine taking a drug to market, only large pharmaceutical companies can really afford to do that…you need GMP manufacturing, you need clinical trials, you need safety assays…it's a very expensive deal. In Scotland we don't have that level and the amount of money required."* (Informant #13)

RM venturing requires bridging this funding gap between stem cell innovations and translation. Achieving this is highly uncertain, since RM commercialization activities generally exceed investor timeframes and investment limits. High levels of uncertainty also surround manufacturing, scale-up and distribution: *"…so you have all sorts of problems as to how you scale out and manufacture…"* (Informant #2)

RM ventures also face high levels of regulatory uncertainty, especially unresolved IP rights issues: *"Not only is the regulatory path as expensive as a pharmaceutical with a potentially smaller market, it's also got a huge amount of uncertainty."* (Informant #10) Legislative changes regarding the use of human embryonic stem cells (hESCs) has resulted in the shift to induced pluripotent stem cells (iPSC) but has required ventures to adapt their business model as a consequence. iPSC are seen as more ethically acceptable, but ethical uncertainties still surround the RM sector. Furthermore, scientific shifts are likely because stem cell science is still in its infancy.

Many of the uncertainties discussed within the dataset are consistent with previous research (Plagnol *et al*, 2009). Some ventures are not fully committing to this sector, deploying limited resources until uncertainty (and risk) is reduced. Therefore, if the sector is to see advancements in RM venturing, these uncertainties must be addressed. To achieve this, RM ventures are engaging in collaborations, legitimacy building and knowledge exchange mechanisms.

University entrepreneurial culture. University academic scientists may be expected to participate in commercialization activities. This requires the inventing entrepreneur to modify their role-identity, shifting from a scientific orientation to a more market-driven approach (George and Bock, 2008; Jain *et al*, 2009). However, this often creates conflicting pressures as academics are measured on research papers and grants, not commercialization outcomes: *"…there's a tension here isn't there? Academics are judged by their papers and their grants…Spinouts take a lot of time and a huge amount of work…group leaders find that extremely difficult because that's time that they're not doing their academic work and ultimately they will be judged with the current metrics much more on their academic work then they will on their commercialization work."* (Informant #9) This tension could impact their motivation for commercialization (Etzkowitz, 1998; Ndonzuau *et al*, 2002).

Technology transfer offices (TTOs) play an important role in encouraging an entrepreneurial culture for academics (Lerner, 2005). The business development capabilities of TTO staff can also influence commercialization (Lockett and Wright, 2005; Thursby and Kemp, 2002). Some staff may lack the technical and entrepreneurial understanding that is required to commercialize stem cell science (Lockett *et al*, 2005): *"I guess again that comes down to their tech transfer department to do that. Again, will they necessarily understand? I don't think so?"* (Informant #1) RM venturing will, therefore, ultimately depend on universities deinstitutionalizing their traditional academic culture and adopting a more commercially oriented and entrepreneurial one (Dacin *et al*, 2002; Scott, 2001).

Coping strategies. In order to address high levels of PEU, entrepreneurs or ventures will be required to engage in coping strategies (Milliken, 1987). Our findings show entrepreneurs and ventures engaging in collaborations and legitimacy building, in order to address the high levels of PEU.

The majority of collaborations are taking place for resource assembly purposes: *"…so we have access to the cell lines, or at least some of them, from [company name]. That's a collaboration"* (Informant #3), and improving particular processes: *"…the idea is that we can work with them and take some of the processes and tune them up for proper manufacturing."* (Informant #15) Collaborations also provide access to funding and can build the legitimacy of a particular venture. Collaborations with industry and academia appear to be the most dominant types of collaboration within the dataset. Collaborations with the NHS are also vitally important for RM venturing, as they enable access to clinicians. However, gaining access to the NHS and forming a collaborative partnership is currently challenging:

"Access to the NHS is very challenging in Scotland…it's just something that's not happened in Scotland." (Informant #11) Collaborations involving support entities provide ventures with access to executives with expertise in new venture development. They also facilitate in connecting ventures with investment communities. However, despite the benefits of collaborations, costs associated with collaborations were evident.

In addition to the role of collaboration in addressing the high levels of PEU, uncertainty reduction is also possible as a consequence of legitimacy building. Entrepreneurial stories were evident within the dataset as a means of legitimacy building and serving to reduce uncertainty: *"…we had been talking to him, and talking to him, and talking to him. And he didn't, at first, believe that our technology did what it said it did because it is a paradigm shift for stem cell technology…and we get a lot of people who don't believe it, although less and less. We are able to show people stuff now that makes them realize that's it's the real deal…"* (Informant #2) Protection of stem cell research, publicizing RM technology through raising awareness, and influencing key stakeholders was also evident within the dataset as a means of legitimization.

Collaborative knowledge. Coping strategies can enable access to knowledge for venture formation and growth. Our findings highlight the exchange of knowledge and communication between the various actors operating within the RM sector. Knowledge is accessed through collaborations: *"I'm working with [name of collaborator] and we are developing techniques which hopefully will have commercial applications in the future. So it's kind of using my communication skills and knowledge of embryology and his knowledge of transgenics and how that works."* (Informant #4)

Networks are also important for knowledge access: *"…we got them to meet some companies through our network…to find out what they're doing, swap information, so that kind of activity, I mean, knowledge transfer, it's community building, access to funding and access to partners for collaboration would be the strap line."* (Informant #12) Knowledge access is especially valuable because it can enable capability development: *"…we had a knowledge transfer partnership with the university… and really that was used to sort of develop our capability in creating cell lines that basically took on the form of hepatocytes."* (Informant #7) However, informants did discuss the difficulties in exchanging knowledge due to the language differences between the various actors within the sector and due to the tacitness of RM knowledge.

Social networks have been suggested to be an important mechanism for the assembly of resources and in the creation and exchange of knowledge (Aldrich and Martinez, 2001; Ardichvili *et al*, 2002). Within the RM sector there are several life science communities that have been established, with the aim of ensuring successful RM venturing. For example, The Health KTN organizes events and workshops where RM industry actors can meet in order to share ideas and gain access to potential collaborators. This network also acts as a facilitator for the identification of new sources of funding.

Narratives of venture potential. Accessing resources, including knowledge, through collaborations and networks can enable RM ventures to form and grow. During this venture development period, ventures may continue to engage in coping strategies resulting in additional collaborative knowledge. However, RM venture development is challenged due to a lack of slack resources, especially financial resources. Governmental funding appears to be available for basic scientific RM research and to progress RM research to phase I/II studies. However, access to funding for clinical stage research and to deliver this research to the market is currently challenging: *"…because at the moment people in regenerative medicine talk about a funding gap and you'll hear this from many people, but preclinical stuff...is great, it's all academic. You then sort of do proof of concept stuff which is fundable because it's fairly cheap, but then there's this clinical development which is extremely expensive and small companies can't afford it, universities certainly can't afford it."* (Informant #3) At present, entrepreneurs and early stage RM ventures are required to match governmental funding with their existing financial resources, which is difficult.

Business model evolution through trial-and-error was exemplified within the dataset. When complexity and uncertainty are high, ventures may run multiple parallel business models and select the best performing one (Loch *et al*, 2008): *"The other part to it which actually never really materialized…we also thought there was the opportunity of people actually utilizing our facilities to undertake that work. In reality that bluntly didn't happen for whatever reasons…what we did, to some extent, is move away from a company that was almost a service company to one that would eventually have product or products based on IP in one form or another, whether patented or not, that we could then market."* (Informant #7)

Informants also discussed uncertainty surrounding their own business model, in some cases discussing business model failure or changes to their current business model due to a lack of market demand. This highlights that RM business models cannot be predicted *ex ante*. Entrepreneurs discussed their desire to become players in the RM therapeutics market, but

due to the high uncertainties and costs of being involved in this market, all were prevented from operating in this space. Therefore, it appears from the dataset that RM ventures focusing on tools or diagnostics may have a clearer path to a viable business model than those focusing on therapeutics. This is because the financial resources required for commercialization of tools or diagnostics is significantly lower than the financial resources required to commercialize therapeutics. However, given the current uncertainty within the RM sector, young RM tools or diagnostic ventures are likely to face downstream uncertainties such as reimbursement uncertainties.

University-led RM venturing has the potential to result in significant economic gains. However, it should not be forgotten that failure is an unavoidable aspect of any entrepreneurial venture and even if universities are successful in transferring their technology, they should not always expect the economic gains to accrue to their local area (Miner *et al*, 2001). Informants, especially RM support entities, were concerned with RM venturing positively impacting the local economic environment. However, there was some concern as to whether the local environment could retain this innovation.

Despite the high uncertainty surrounding RM venturing, suggestions by informants for the trajectory of the market were forthcoming. Informants also discussed the timeframes involved for RM scientific progression and widespread venturing. The expected timeframes for taking RM science to market differs amongst the actors operating within the sector. VCs, SMEs and the UK government do not understand the timeframes involved in taking RM science to market, according to entrepreneurs and RM support entities. VCs, SMEs and the UK government expect a much quicker return on investment and as a consequence, this has serious implications for RM funding and, ultimately, commercialization: *"…the time horizons of a VC investment just don't fit the time horizons of a development of a therapeutic…so the VCs intending to sell it either to other VCs or to trade sale it…I really don't like that model, it just doesn't fit."* (Informant #10)

Our data also highlights differences in how each category of informant addresses uncertainty and RM venturing. Findings suggest the relevance of two role-based sensemaking lenses, which likely influence or complement the coping strategies in use. We illustrate these two role-based lenses in Figure 1.

Lens 1 consists of the average occurrence of each theoretical dimension for academics and support entities. Both place a higher emphasis on university entrepreneurial culture and collaborations. The purpose of these collaborations is to progress scientific developments and improve current RM processes.

In contrast, lens 2 consists of the average occurrence of each theoretical dimension for RM entrepreneurs and RM companies. Both approach venturing in a comparable way and have similar perceptions of uncertainty, including the significance and effect of uncertainty. They also both face the same concerns in relation to funding uncertainties. RM entrepreneurs and companies both lack slack resources and place more emphasis on narratives of venture potential.

Figure 1 here

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5. Discussion

The qualitative findings suggest a model of sensemaking under irreducible uncertainty. We consider the emergence of different coping strategies that reflect the situational understanding of RM ecosystem participants during venturing. Coping strategies affect collaborative knowledge development and the resulting narratives of venture formation and growth. We consider alternative approaches to collaboration and generate a typology of sensemaking under uncertainty. We also discuss the effect of uncertainty on institutional culture.

5.1. Sensemaking in RM venturing

The theoretical dimensions generated by the qualitative analysis reveal a model of sensemaking in RM venturing, shown in Figure 2. PEU and institutional entrepreneurial culture affect the individual's preferred coping strategy. The chosen coping strategy then influences both the generation of venture narratives as well as collaboration efforts. A key purpose of venture narrative is the legitimization of the firm's innovation or business model. We therefore expect that the venture narrative and knowledge collaboration efforts interact. Our study is not longitudinal, so we are unable to consider how this interaction shapes the actual growth, development or success of a given venture.

Figure 2 here

5.2. Coping with high PEU

By definition, PEU is a subjectively determined assessment of uncertainty. Informants described a variety of relevant uncertainties, including funding issues; manufacturing, scale-up and distribution uncertainties; regulatory uncertainties; scientific uncertainties; ethics; and reimbursement uncertainties. These are consistent with prior analysis of the industry (Ledford 2008). At a fundamental level, PEU describes environmental unpredictability (Buchko, 1994; Milliken, 1987). Freel (2005) discusses three separate dimensions of PEU, which involves uncertainties related to the firm's resources/environment, the firm's industrial/market environment and the firm's economic environment. According to this categorization, funding issues would, therefore, belong to the firm's resources/environment PEU dimension. Thus, coping strategies appear to be part of the cognitive mechanism associated with incorporating the uncertainty into the organizational development strategy.

We have shown coping strategies to include collaborations and legitimacy building. These depend on culture and uncertainty, and affect collaborative knowledge development and the resulting narratives of venture formation and growth. Coping includes problem-focused and emotion-focused coping. Several forms of problem-focused coping have been identified, such as *specific interpersonal efforts to alter the stressful situation* or the *seeking of social support* (Folkman *et al*, 1986b). The specific problem-focused coping form implemented by entrepreneurs is likely to have differing effects on resource assembly and collaborative knowledge development. For example, RM entrepreneurs implementing problem-focused coping, in which they seek social support, may find that they are unable to assemble resources and develop collaborative knowledge. Seeking social support relies on entrepreneurs obtaining external advice, assistance or knowledge. Yet, if support is sought from RM individuals who have coping strategies linked to venture failure, resource assembly and collaborative knowledge development will be challenged.

Emotion-focused coping strategies enable entrepreneurs to manage their emotions in relation to the uncertainty and are most suited to uncontrollable situations. Therefore, they are especially valuable to entrepreneurs and ventures during RM venturing due to the high levels of irreducible uncertainty surrounding RM. Several forms of emotion-focused coping strategies exist, which can facilitate or inhibit problem-focused coping. These include: *denial*, *wishful thinking*, *distancing*, *emphasizing the positive*, *self-blame*, *tension-reduction* and *self-isolation* (Folkman *et al*, 1986a). Again, we can expect resource assembly and collaborative knowledge development to proceed differently depending on which form of emotion-focused coping is adopted. For example, entrepreneurs relying on wishful thinking may fail to see

potential flaws in their business model or RM technology. If they then collaborate for resource assembly and knowledge development purposes, homophily effects suggest that the collaborating firm will also fail to see the potential flaws. This will have serious consequences on venture formation and growth. Therefore, we propose that:

> **Proposition 1**: Under high levels of PEU, coping strategies relying on wishful thinking or denial are associated with reduced knowledge collaboration and venture narratives that emphasize the venture's current innovation as the key component of a successful business model.

> **Proposition 2**: Under high levels of PEU, coping strategies relying on problem-solving or exploration are associated with increased knowledge collaboration and venture narratives that emphasize addressing a specific market need as the key component of a successful business model.

Our findings have confirmed that individuals differ in their perceptions of uncertainty (Duncan, 1972) and in their coping responses (Carver *et al*, 1989). We have reported that entrepreneurs rely less on coping strategies for venture development than any of the other RM participants in our study. The UK government's commitment to RM commercialization has encouraged a wide range of support entities, which we have shown to rely heavily on collaborations as a coping strategy to the high levels of PEU. In some instances, support entities are measured on the number of collaborations that they establish. Therefore, we see RM support entities actively encouraging RM firms and entrepreneurs to engage in collaborations. Yet, our situational analysis reveals that this conflicts with how RM entrepreneurs deal with high levels of PEU. Conflicts towards the best commercialization pathway may prove to be detrimental to RM venture formation and growth. Irreducible uncertainty and variations in the best commercialization path, could lead to the grouping of RM informants based on homophily effects. This may have serious implications for venture outcome, as groups will either randomly all succeed or fail based on whether their interpretation of the best commercialization path was accurate or not (Miner *et al*, 1996). Thus, support entities that are at odds with entrepreneurs' coping strategies are unlikely to provide useful support, unless they are in fact converting entrepreneurs to coping strategies that are linked more to success.

5.3. Collaboration under irreducible uncertainty

Our findings indicate that entrepreneurs rely on coping strategies less than any other category. Findings also indicate that costs exist during collaborations and unwilling collaborators. In addition, given the high levels of PEU, high partner uncertainty is expected. Under conditions of high collaboration costs, unwilling collaborators and high partner uncertainty, it is possible that RM entrepreneurs and new ventures rely on selective revealing as an alternative strategic mechanism to known collaboration mechanisms (Alexy *et al*, 2103). However, the use of selective revealing strategies in RM venturing may be problematic. If the focal firm is associated with coping strategies that are linked to venture failure, then we propose that collaborative networks of ignorance will be created, since the external firm also becomes associated with coping strategies linked to venture failure. This will have serious implications for the development of collaborative knowledge, since opportunity recognition depends on individuals mentally comparing new information with prior knowledge through a cognitive process of structural alignment (Grégoire *et al*, 2010). Therefore, we expect that:

> **Proposition 3**: Coping strategies, which rely on selective revealing during collaboration, are associated with partnering that favors firms with similar business models as the focal firm.

5.4. Institutional culture

RM venturing is driven by university-led stem cell research. The embedded institutional culture and processes at the university and TTO are likely to have an imprinting effect on the structure and characteristics of RM ventures which emanate from the university (Kimberly, 1975; Stinchcombe, 1965). At founding, new ventures are determined by the specific technological, economic, political and cultural resources that are available to them (Johnson, 2007). To ensure their survival and growth, they must follow strategies that are rewarded by their external environment (Kriauciunas and Kale, 2006). However, since RM ventures operate under extended periods of high levels of uncertainty, it is reasonable to suggest that imprinting effects will have unintended outcomes on the survival of young RM ventures. Therefore, imprinting effects and the inventing academic-entrepreneur's prior role-identity conflicts presents significant challenges to RM venturing. We suggest that:

> **Proposition 4**: A weak entrepreneurial culture in the parent institution is associated with emotion-based coping strategies in its spin-off ventures.

Proposition 5: A strong entrepreneurial culture in the parent institution is associated with problem-based coping strategies in its spin-off ventures.

5.5. A typology of knowledge collaboration during venturing under high uncertainty

Combining the role-based lenses with the coping strategies generates a typology of sensemaking profiles under uncertainty. The generation of archetypal sensemaking approaches to inherently uncertain activities presents a useful tool for entrepreneurs, research institutions and policymakers to better understand and potentially influence the evolution of an entrepreneurial ecosystem. The typology is shown in Figure 3.

Figure 3 here

Focused visionaries are participants in the RM ecosystem that have settled on a key innovation or business model and plan to see it through regardless of the development of alternative innovations or collaborative opportunities.

Informed observers have similarly determined a relatively set position with regard to technology or innovation but are not actively engaged in commercialization.

Open innovators are individuals engaged in commercialization activity based on a primary technology, but are willing to take the risk of collaboration in order to best address a given market problem.

Curious bystanders are not directly involved in commercialization, but have specific market problems or industry needs in mind and encourage collaboration for the sake of improving the knowledge of the ecosystem as a whole.

At this time, we have no information on whether ecosystems benefit more from some sensemaking profiles than others or whether a specific mix or blend of sensemaking profiles is somehow advantageous. We speculate, however, that the level of uncertainty in RM has differential effects on individuals, firms and the ecosystem based on sensemaking profiles. For example, small ecosystems with relatively limited capital and knowledge resources likely reward focused visionaries over open innovators, because they present a more compelling narrative to legitimize the venture and its business model. By contrast, curious bystanders may be favored in nascent ecosystems because they enable trusted exchange of information without extensive and costly contracting requirements. Larger ecosystems still operating under significant uncertainty might favor the opposite profiles. Open innovators that

emphasize clear market opportunities may ultimately attract more venture capital through venturing development activities that emphasize capability development rather than narrow technological testing. Similarly, the presence of larger networks of service and financial experts may obviate the need for curious bystanders, increasing the relative value of informed observers who are aware of untapped innovations that can be tested with minimal resource combinations.

5.6. Limitations and directions for future research

As this is an exploratory study, the sensemaking model should be tested via empirical analysis. The inductively derived theories of RM venturing proposed in this study also require further testing, refinement and development through further empirical research. The dataset is limited primarily to RM venturing informants in Scotland. Similarities in RM sector development across western geographies suggest that findings have broader relevance, but caution should be exercised beyond early stage RM ecosystems in western economies. The dataset over represents RM support entities, therefore, further data collection should focus on pre-venture academic entrepreneurs and *de novo* RM firms.

Despite these limitations, our results emphasize the importance of research linking entrepreneurial cognition and decision-making to venture process, especially under high levels of uncertainty. This study opens pathways for future research to reveal the full nature of individual and organizational coping responses during opportunity exploitation and under high levels of PEU. This may distinguish which coping strategies are linked to success or failure in context. From this, we can gain a deeper understanding of coping strategies for the assembly of resources, the development of collaborative knowledge and venture outcome. Further research in this area also has strong potential to clarify the characteristics of mindsets that distinguish academic entrepreneurs from industry entrepreneurs. We also call upon further research on the existence and role of selective revealing in RM venturing, particularly the drivers and outcomes of this alternative form of collaboration mechanism. This is consistent with further research calls from Alexy *et al* (2013). Finally, our findings also encourage further studies to understand the effects of prolonged periods of PEU to environmental imprinting and the survival of young RM ventures.

5.7. Policy implications

Our study points towards specific policy implications regarding entrepreneurial training, ecosystem development, and university entrepreneurial culture.

First, many universities have begun offering entrepreneurial training to academics that self-select for potential commercialization of their research-based innovations. In knowledge-intensive fields that operate under high levels of uncertainty, the merits of such training may be difficult to measure. In addition to developing traditional business skills, academic entrepreneurs report needing to adjust their mindset to operating within an entrepreneurial framework (George and Bock, 2008). In fields requiring significant scientific capabilities, such as RM, fostering effective academic entrepreneurship may require investing in experiential training that directly addresses coping with failure and collaborative knowledge development.

Second, the role of government in technology ecosystem development requires careful consideration. The state has an important role to play in developing novel university-based technologies whose potential is not yet understood by the business community (Etzkowitz, 2003; Mazzucato, 2013). The nature of policies that support ecosystem development in nascent technology sectors, however, has not been broadly tested. Government support for the growth of an extant, healthy ecosystem is primarily one of addressing market failures, such as lack of growth capital and access to markets. In nascent, high-uncertainty ecosystems, such as RM, downstream markets may not yet exist, and supplemental growth capital would likely go unused or be lost in purely speculative ventures. The development of entrepreneurial ecosystems depends on more than environmental conditions and institutional policy (Bock and Johnson, 2016).

Third, universities must consider entrepreneurial culture as well as commercialization policy. Our sensemaking model highlights the role of institutional culture on the development of an individual's preferred coping strategy. Entrepreneurs are adept at finding, adapting and exploiting undervalued resources, often through novel, unexpected, or even counter-institutional processes (Anderson and Warren 2011). The academic entrepreneurs most likely to succeed will do so by exploiting supportive policies and side-stepping inhibitive restrictions. In other words, universities may need to be less concerned about policies that support successful entrepreneurial action, and more concerned about fostering an environment and culture that encourages entrepreneurial action in the first place.

6. Conclusions

We investigated entrepreneurial activity within RM venturing, which is a sector characterized by unusually high levels of uncertainty. Our study advances theories of sensemaking under irreducible uncertainty by proposing a model linking uncertainty,

sensemaking, coping and collaborative knowledge development. Findings present a novel picture of organizational coping under high levels of uncertainty. We suggest the need for entrepreneurs and new ventures to adopt coping strategies in response to the high levels of PEU, which can result in the development of collaborative knowledge and venture development. Entrepreneurs and new ventures, which fail to adhere to this, may find themselves unable to develop their business model.

We have also progressed the understanding of university-industry scholarship by showing an association between university culture and venture coping strategies. Therefore, these findings are especially useful to TTOs. We recommend that universities and TTOs, which expect to commercialize their stem cell research, need to consider balancing their academic and commercialization culture.

Our research also has implications to UK government policymakers, who are not only charged with ensuring that the UK remains at the forefront of RM research, but also with the commercialization of this research.

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Tables and Figures

Table 1. General information about the Scottish regenerative medicine ecosystem

Population of Scotland	5 295 000
GDP for Scotland	£150 billion
Capital city of Scotland	Edinburgh
Population of Edinburgh	495 360
Significant local industries	Education, health, finance, insurance, agriculture, tourism and whiskey
VC in region	<5
University of Edinburgh (UoE) student population	30 579
UoE annual research budget	£286 million
University research income	£316 million
UoE College of Medicine faculty	2594
Medical research	Estimated £109 million
UoE TTO activity	TTO founded in 1969. 423 patents filed 2007-2012. £3.5 million license/royalty income in 2011. 160+ active commercial license agreements. 171 spinout/start-ups since 1969.
UoE RM patents granted between 2009-2011	9
UoE RM publicity	Dolly the sheep

Note: All data for 2012-2013 unless otherwise noted.
Sources: University of Edinburgh and subsidiary School/College websites and Annual Report, and Scottish Government websites (including UK Intellectual Property Office).

Table 2. Study informant information

#	Informant's role	Category	Organization type	Location
1	Director of Operations	Support entity	Services	Edinburgh
2	CEO & Founder	Entrepreneur	Tools/Diagnostics	Glasgow
3	Business Development	RM company	Services/Research	Edinburgh
4	CEO & Founder	Entrepreneur	Services/Research	Edinburgh
5	Academic scientist	Academic scientist	Research	Edinburgh
6	Economic Development	Support entity	Services	Edinburgh
7	CEO	Support entity	Services	Edinburgh
8	Business Development	Support entity	Research	Edinburgh
9	Director & Academic	Academic scientist	Research	Edinburgh
10	CEO & Founder	Entrepreneur	Cell Therapy	UK
11	Industry Liaison Manager	Support entity	Services	Glasgow
12	Technology Manager	Support entity	Services	UK wide
13	CEO & Founder	Entrepreneur	Services/Diagnostics	Edinburgh
14	CSO & Founder	Entrepreneur	Services	Glasgow
15	CEO	Support entity	Services/Research	UK wide
16	CEO	RM company	Tools/Diagnostics	UK
17	Outreach Manager	Support entity	Services	Scotland
18	International Executive	Support entity	Services	Scotland
19	Entrepreneur	Entrepreneur	Tools/Diagnostics	Scotland
20	CEO	Support entity	Services/Research	Edinburgh
21	Business Development Head	Support entity	Services/Research	Edinburgh
22	Academic scientist	Academic scientist	Research	Edinburgh
23	Business Creation Head	Support entity	Services/Research	Edinburgh

Table 3. Summary of pilot survey findings

Survey statements	Key findings – participants' response to statement
Regenerative medicine commercialization is challenging due to the resource constraints faced by organizations	45% agreed 32% strongly agreed
Collaborations are required for regenerative medicine commercialization	45% agreed 32% strongly agreed
Governmental funding can be accessed for regenerative medicine commercialization	32% agreed 23% strongly agreed 18% disagree
Unresolved regulatory issues are affecting regenerative medicine commercialization	64% agreed
Knowledge is exchanged during collaborations	55% agreed 36% strongly agreed
Collaboration with hospitals is necessary for regenerative medicine commercialization	41% agreed 36% strongly agreed
Unrealistic timeframes are set for regenerative medicine commercialization	41% agreed 27% strongly agreed 18% neither agree or disagree
Collaborations with academic institutions are necessary for regenerative medicine commercialization	45% agreed 27% strongly agreed
Venture capital funding can be accessed for regenerative medicine commercialization	32% disagreed 32% agreed 23% neither agree or disagree
Regenerative medicine collaborations often fail to deliver	36% disagree 32% neither agree or disagree 23% agree
Collaborations can provide early stage regenerative medicine ventures access to resources	45% agree 27% strongly agree
Collaboration with "big pharma" is necessary for regenerative medicine commercialization	50% disagree 18% neither agree or disagree
Manufacturing, distribution and scale-up uncertainties are affecting regenerative medicine commercialization	36% agree 23% neither agree or disagree 18% strongly agree
Regenerative medicine collaborations are difficult to manage	41% disagree 23% agree 18% neither agree or disagree
Regenerative medicine collaborations are costly	27% neither agree or disagree 27% agree 18% strongly agree
Regenerative medicine business models are unknown and unproven	32% strongly agree 32% don't know
Collaborations enable regenerative medicine organizations to acquire capabilities	64% agree

Table 4. Data structure

Prevalence in study sample (%)*					1st Order Codes	2nd Oder Codes	Theoretical Dimensions
T	E	A	SE	RC			
61	83	67	50	50	Risk	Types of uncertainty	Perceived environmental uncertainty (PEU)
74	100	67	58	100	Funding issues		
43	33	67	42	50	Mfg, scale-up and distribution uncertainty		
39	50	0	42	50	Regulatory uncertainty		
17	17	33	17	0	Scientific uncertainty		
17	33	0	8	50	Ethics		
13	17	0	17	0	Reimbursement uncertainty		
39	17	33	58	0	Academic conflicts	Inventing entrepreneurs	University entrepreneurial culture
39	17	67	50	0	Academic motivations		
30	0	67	42	0	Academic metrics		
35	17	0	58	0	TTO goals and activities	TTO goals and activities	
91	83	67	100	100	Collaborations with industry	Collaborative partners	Coping strategies
74	33	100	83	100	Collaborations with academia		
39	17	33	50	50	Collaborations with NHS		
35	0	33	50	50	Collaborations with support entities		
39	67	67	17	50	Collaboration for sharing of resources	Collaborative outcomes	
30	17	33	25	100	Collaboration for process improvement		
22	0	67	25	0	Collaboration for funding purposes		
9	17	33	0	0	Collaboration costs		
4	17	0	0	0	Collaboration for legitimacy building		
61	83	67	58	0	Legitimacy building	Legitimacy building	
57	67	0	67	50	Knowledge transfer	Resource exchange mechanisms	Collaborative knowledge
70	50	100	75	50	Communication		
22	50	33	0	50	Learning		
26	17	33	33	0	Language differences		
57	50	33	75	0	RM and scientific communities	Networks	
87	83	67	92	100	Governmental funding	Funding sources	Narratives of venture potential
61	83	33	58	50	VC funding		
35	0	100	33	50	"Big pharma" funding		
65	50	67	75	50	Spinout venture formation	Spinout venture formation	
61	83	67	58	0	Legitimacy building	Trial and error business models	
57	100	33	33	100	Business models		
9	33	0	0	0	Integrated business model		
78	83	100	75	50	Resources	Existing resources	
30	17	33	33	50	Innovation	Economic development	
30	0	0	58	0	Regional investment and growth		
65	67	67	58	100	Commercialization timeframes	Future scenarios	
9	17	33	0	0	Potential industry structure		

* Does not account for multiple occurrences within a single interview. T = Total sample; E = Entrepreneur, A = Academic; SE = Support entity; RC = Regenerative medicine company

Figure 1. Revealed significance of uncertainty and venturing

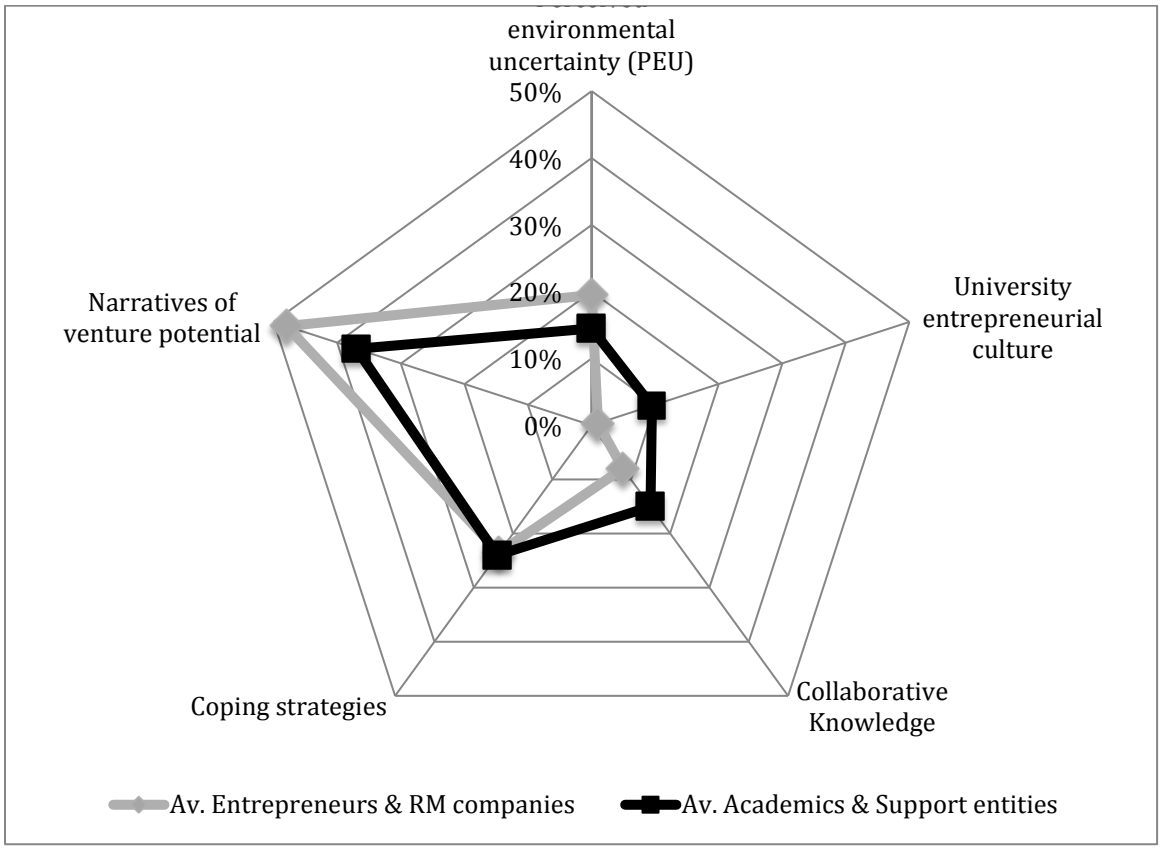

Figure 2. A model of sensemaking process in RM venturing

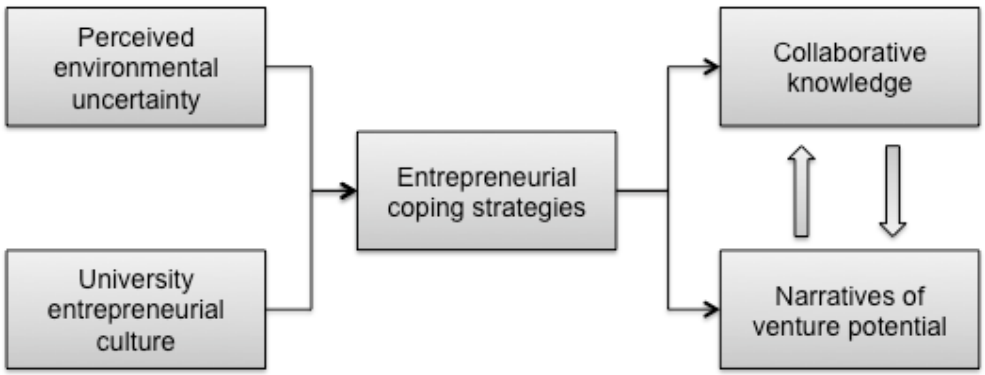

Figure 3: Sensemaking types in uncertain entrepreneurial ecosystems