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Opportunity Evaluation in Teams: A Social Cognitive Model

ABSTRACT

Research on opportunity evaluation is flourishing but we know little about how teams evaluate opportunities rather than individuals. Conceptualizing opportunity evaluation as a collective process, we develop an agent-based model to investigate how the social cognitive mechanisms of team formation affect the ability of entrepreneurial teams to choose good opportunities and forgo bad ones. We find that opportunity evaluation decisions depend on the cognitive status of the lead entrepreneurs who found the team and the team formation strategy they use, i.e., whether they select team members based on interpersonal similarity (i.e., cognitive homophily) or complementary knowledge (i.e., cognitive heterophily). Moreover, we show that learning moderates the effects of team formation on opportunity evaluation. Overall, our work provides a new view of opportunity evaluation as a dynamic social process contingent upon entrepreneurs' networks and team founders' characteristics and their choices of who to turn for judgments of an opportunity's potential.

Keywords: Cognitive centrality; entrepreneurial teams; opportunity evaluation; homophily; team formation.

1. Executive Summary

The evaluation of opportunities is a central stage in the entrepreneurial process. Evaluating opportunities is important because it is the judgment that an opportunity is potentially valuable that triggers entrepreneurs to take action to shape a new business idea and form a new venture. In recent years, a considerable amount of research has sought to explore how individual entrepreneurs evaluate opportunities, looking at how individuals use their idiosyncratic knowledge and perspectives to build a picture of the potential value of opportunities. However, in many instances new business ideas are formed and evaluated in *teams*, including start-up and new venture teams. To date, we know little about how teams evaluate opportunities rather than individuals.

To fill this gap, we develop a new model of opportunity evaluation in teams. We focus on the early stages of evaluation where start-up teams come together to develop a clearer picture of which opportunities are most valuable and decide which ones to pursue. Our analysis focuses in particular on the effects of team formation. Team formation is the process by which founders – whom we term lead entrepreneurs on account of their role in establishing the team – form the team by recruiting others into it. Team formation is especially important because it shapes the composition of the team, which in turn determines whose knowledge is used to evaluate opportunities.

Using an agent-based simulation model, we show that the ability to accurately judge the value of potential opportunities depends on the status of lead entrepreneurs and the team formation strategy they use. Our findings reveal that being cognitively central in one's social network can be an advantage for lead entrepreneurs since it allows them to effectively recruit expertise when evaluating potential opportunities. Our results also reveal when it is best for founders to recruit people who have similar or dissimilar knowledge. When recruiting evaluators from among people who have already learned about the opportunity at hand, it seems better to recruit people who have similar knowledge. Conversely, when recruiting evaluators into the team who then learn about the opportunity at hand, it seems better to recruit people with dissimilar knowledge. We discuss why these strategies are effective under different conditions.

Our model and findings make three significant steps forward in understanding opportunity evaluation. First, they demonstrate that variations in how opportunities are evaluated can be traced to differences in how founders build the entrepreneurial team. Second, they provide new insights into the skills needed to effectively evaluate opportunities at the collective level. We go beyond the individual mental processes involved to also consider the skills required to build a team that can effectively judge the potential value of new ideas. Finally, and overall, we provide a new view of opportunity evaluation as a dynamic social process that depends on entrepreneurs' networks, their choices of who to seek judgments from, and on the timing of team formation.

2. Introduction

Understanding how entrepreneurs evaluate opportunities is a central goal of entrepreneurship research (Haynie & Shepherd, 2009; McMullen & Shepherd, 2006; Scheaf et al., 2020; Wood & McKelvie, 2015; Wood & Williams, 2014). The evaluation of opportunities is a distinctive and important part of the entrepreneurial process, alongside the initial discovery and subsequent exploitation of opportunities (Shane & Venkataraman, 2000; Wood & McKelvie, 2015). Evaluation is important for two main reasons. Without a favorable evaluation of the idea for a new good or service, entrepreneurs would not take purposive action (Kirzner, 1979; Wood & McKelvie, 2015). Furthermore, an accurate evaluation of the potential gains and losses associated with an opportunity can provide entrepreneurs with an advantage, whereas errors in such judgments can lead them to waste resources on unfruitful ideas (McMullen & Shepherd, 2009; McMullen et al., 2007).

To date, scholars have largely focused on how *individuals* evaluate opportunities (for a review, see Wood & McKelvie, 2015). Research has examined the cognitive biases that afflict individuals' evaluations (Keh et al., 2002), how they mentally represent opportunities (Haynie et al., 2009), and the decision rules they use (Wood & Williams, 2014). Rarely have researchers

considered how *teams* evaluate opportunities. This is an important oversight since most new ventures begin when two or more founding entrepreneurs come together in a team to pursue a potential opportunity (Cooney, 2005; Lazar et al., 2020; Wasserman, 2012).

Anecdotal evidence suggests that opportunity evaluation is often a team affair. The founding of Netflix provides a telling example. Marc Randolph (2019: 2), Netflix's founding CEO, describes how he and Reid Hastings evaluated business ideas together. First they jointly screened ideas using "a rapid-fire evaluation of pros and cons, a high-speed cost-benefit analysis". Then, working with Hastings and two other carefully selected associates, Randolph and his team met frequently to evaluate the possible gains from promising opportunities, from personalized shampoo to custom baseball bats, before settling on the idea of DVD by mail. They used the team to subject ideas to rigorous assessment from multiple viewpoints. Ideas unsupported by the prevailing sentiment were abandoned. For Netflix, the collective evaluation of market size and possible earnings continued among the four main protagonists throughout development of the idea.

Our overarching goal in this article is to extend current research to better account for the interdependent nature of opportunity evaluation in teams. We confine our attention to startup teams and new venture teams trying to find opportunities to exploit in their initial stage of development. At this early stage of the entrepreneurial process, individuals often come together in small teams to assess various opportunities and find potentially valuable ones for further engagement and examination (Ardichvili, Cardozo & Ray, 2003; Bakker & Shepherd, 2018).

To better understand these dynamics, we conceptualize opportunity evaluation as a collective process (for a similar view, see Ruef, 2010). From this perspective, evaluating opportunities as a team provides access to a greater breadth of knowledge and varied expertise, which enables entrepreneurs to assess a wider range of opportunities and evaluate them more

rigorously (Foss et al., 2008; de Mol et al., 2015). However, conceiving opportunity evaluation as an collective process also highlights how decisions regarding which opportunities are most promising and should be pursued depend on who entrepreneurs interact with. Accordingly, we focus our analysis on the process of team formation; that is, who founds the entrepreneurial team and how they recruit others into it (Lazar et al., 2020). We focus on team formation because it determines the composition of the team and thus whose knowledge is used to make judgments (Arrow et al., 2000). The collective knowledge base matters because entrepreneurs use their extant knowledge to evaluate opportunities (Wood & McKelvie, 2015).

Although research shows that team formation is important to entrepreneurial activity in general (Aldrich & Kim, 2007; Lazar et al., 2020; Ruef, 2010) its effect on opportunity evaluation is unclear. Researchers recognize that individual 'lead entrepreneurs' such as Marc Randolph play a key role in founding entrepreneurial teams (Lazar et al., 2020) but important questions remain regarding how they and their choices affect the team's ability to evaluate opportunities. Are some lead entrepreneurs better positioned to form a team that can evaluate opportunities effectively? Is it better for them to choose like-minded associates when evaluating ideas or solicit opinions from those with diverse knowledge? And once lead entrepreneurs have formed a team to provide multiple evaluations, how should they integrate them into a shared evaluation of the value of an opportunity? As Wood and McKelvie's (2015) review makes clear, these are important questions that research on opportunity evaluation has not yet addressed. Understanding how the selection of teammates and the integration of their evaluations affects collective judgments and decisions promises not only to expand our understanding of opportunity evaluation but it can also deepen understanding of entrepreneurial team dynamics (Patzelt, Preller & Breugst, 2021).

To examine these questions, we use agent-based modeling to simulate entrepreneurs

forming a team and evaluating potential opportunities. Using simulations enables us to overcome the difficulties of observing or creating early-stage entrepreneurial teams in natural or contrived settings. Agent-based modeling has distinct advantages for studying entrepreneurship as a social process (McMullen & Dimov, 2013), which we exploit here to undertake a series of computational experiments that take into account agents' cognitive characteristics, social interactions, and contextual features including limited resources for learning about opportunities.

Building on recent advances in conceptualizing entrepreneurial teams (Lazar et al., 2020), we examine how two key aspects of team formation create systematic variations in collective evaluations and performance, i.e., the likelihood of choosing valuable opportunities and foregoing loss-making ones. First, we examine the cognitive status of the lead entrepreneur who founds the team. We invoke the concept of cognitive status in a group from research on sociocognitive networks (Aldrich & Kim, 2007; Kameda et al., 1997) to analyze the effects on decisions when lead entrepreneurs emerge because they are cognitively central in their network or because they have demonstrated the expertise required to value opportunities effectively. Second, we examine the effects of the team formation strategy used, namely whether lead entrepreneurs use a strategy of homophily to recruit similar others or heterophily to seek complementary knowledge. We also shed light on the conditions under which different team formation strategies are effective by examining how learning – an important component of the entrepreneurial process (Corbett, 2005; Dimov, 2007) – moderates the effects of team formation. Specifically, we show that the most effective team formation strategy depends on whether lead entrepreneurs form the team by recruiting people who are already knowledgeable about the opportunity at hand or by recruiting individuals who learn about the opportunity after being recruited into the team. In closing, we discuss how our work extends extant research on opportunity evaluation by conceiving this vital step in the entrepreneurial journal as a dynamic

social process that is contingent upon networks and team founders' characteristics and choices of who to interact with.

3. Theoretical background

3.1. Opportunity evaluation

The notion of opportunity has become the defining concept of entrepreneurship research (Shane & Venkataraman, 2000). Entrepreneurial opportunities can be defined as "a set of environmental conditions that lead to the introduction of one or more new products or services in the marketplace by an entrepreneur or by an entrepreneurial team through either an existing venture or a newly created one" (Dutta and Crossan, 2005: 426; for similar definitions, see Grégoire and Shepherd, 2012; Shane & Venkataraman, 2000).

The subjective evaluation of opportunities occupies a central role in theories of the entrepreneurial process, which view entrepreneurs proceeding through phases of opportunity recognition, evaluation and exploitation (McMullen & Shepherd, 2006; Shane & Venkataraman, 2000). Evaluation is considered a crucial component because recognizing that an opportunity exists for someone in the market place (i.e., a 'third-person' belief; see McMullen & Shepherd, 2006) is insufficient to prompt action; entrepreneurs must also estimate its potential value in their own eyes (Kirzner, 1979; Shane & Venkataraman, 2000). Once formed, judgments of the potential value or attractiveness of an opportunity provide the trigger for entrepreneurial action (Shane & Venkataraman, 2000).

Researchers have used varying definitions of opportunity evaluation—from overall judgments of potential value to specific estimates of profitability to more personalized judgments of gains and losses (for an overview, see Scheaf et al., 2020). However, recent research has made great strides in clarifying the concept of opportunity evaluation (for overviews, see Wood &

McKelvie, 2015; Scheaf et al., 2020). Scheaf and colleagues' (2020) demonstrated that opportunity evaluation entails personal judgments of the attractiveness of an opportunity based on potential gains and losses, desirability and feasibility. Building on the idea of opportunity evaluations as first-person subjective judgments (cf. Dimov, 2007; 2011; McMullen & Shepherd, 2006; Wood & Haynie, 2010; Wood, Williams and Gregoire, 2012), we examine how a team of entrepreneurs initially estimates the potential value of opportunities using its idiosyncratic knowledge base. We focus on the early-stage evaluations of opportunities made by startup or new venture teams as they screen opportunities in terms of their potential value (i.e., gains and losses), identifying promising ones from the various opportunities they face and screening them for more detailed evaluation and exploitation. It is at this very early stage that founding entrepreneurs seek out judgments from others to enable them to identify the most promising opportunities, to discern which ones are worthy of deeper engagement.

A critical challenge at this early stage is how to build an accurate picture of the potential value of an opportunity. Research on entrepreneurial alertness and entrepreneurial decision-making both highlight how superior (more accurate) judgments of potential opportunities provide the foundation for effective action; conversely inappropriate judgments can lead to mistakes such as failure to recognize the importance of market events and over- or under-estimation (Choi & Shepherd, 2004; Gaglio & Katz, 2001; Gruber et al., 2015; McMullen et al., 2007). Not only must entrepreneurs distinguish valuable opportunities from unprofitable ones, but they must do this in the face of great uncertainty and limited resources of time and knowledge (Haynie et al., 2009).

To examine how individuals are able to do this collectively in teams, we build on McMullen and Shepherd's (2006) observation that an opportunity reflects an opportunity only for those who are able to discern its market potential, i.e., persons with a knowledge base that is

highly applicable to the recognition and evaluation of this particular opportunity. Conceived thus, the possession of applicable knowledge is the discriminating feature between entrepreneurs that are able to recognize and build an accurate picture of an opportunity and those who are not. Shane and Venkataraman (2000: 222) similarly argued that a key reason some entrepreneurs discover an opportunity that others do not is that they possess "the cognitive properties necessary to value it" (Shane & Venkataraman, 2000: 222). From this view, opportunities will be pursued only by those who possess the cognitive characteristics (a certain degree of domain-specific knowledge) necessary to recognize and evaluate them. We argue that these characteristics are held by teams as well as individuals.

3.2. Opportunity evaluation in entrepreneurial teams: Evaluation as a social process

We contend that the key to building a knowledge base that enables entrepreneurs to discern the value of opportunities is forming the right team. Accordingly, we focus on the team formation process, in particular *who* recruits individuals to provide judgments of an opportunity and *how* they recruit others into the team. Research shows that entrepreneurial team formation shapes team composition, processes and outcomes (Lazar et al., 2020), not least by determining whose expertise is used to make collective judgments and decisions (Forbes et al., 2006). The issue of formation is particularly germane to entrepreneurial teams because they are self-selecting. As Lazar et al. (2020: 30) note "An important feature of entrepreneurial teams is their endogenous formation. These self-selected teams differ from other types of teams in organizations because they are formed organically, rather than exogenously assigned" (Lazar et al., 2020: 30).

We build on Lazar et al.'s (2020) framework of team formation, which views entrepreneurial team formation as a dynamic process that unfolds iteratively over time as members enter and exit the team. This framework distinguishes two key aspects of team

formation that shape team processes and outcomes, namely the origins of the new venture team and the team formation strategy used. Evidence from various settings shows that entrepreneurial teams often originate from the actions of individual *lead entrepreneurs* who search for teammates to help identify, evaluate and exploit an opportunity (Lazar et al., 2020). The second key aspect is the team formation strategy used, which concerns how lead entrepreneurs search for and select people to join the entrepreneurial team. Relatively little research has focussed on the characteristics of lead entrepreneurs but some research suggests that lead entrepreneurs emerge based on their cognitive characteristics (Ensley et al., 2000). Accordingly, we use our model to explore alternative ways lead entrepreneurs can emerge based on cognitive characteristics.

In contrast, researchers have accrued a considerable volume of evidence on the team formation strategies used. Research in economics, psychology and sociology recognizes two predominant strategies: interpersonal attraction and resource seeking. Scholars often attribute an interpersonal attraction strategy to homophily, the tendency to affiliate with those who share similar attitudes and beliefs (Lazar et al., 2020). Homophily shapes the formation of all types of entrepreneurial teams (Forbes et al., 2006; Lazar et al., 2020; Parker, 2009; Phillips et al., 2013), including founding teams (Aldrich & Kim, 2007; Ruef et al., 2003). For instance, founders are attracted to form ventures with friends who have similar beliefs (Francis & Sandberg, 2000) and family members with similar attitudes (Discua Cruz et al., 2013). Such similarity makes it easier to find team members and eases cohesion. In contrast, network scholars emphasize structural aspects of homophily (Ruef et al., 2003). Because people interact with others who have similar characteristics, they form 'local' clusters that "sustain and amplify homophily" (Aldrich & Kim, 2007: 153).

An alternative entrepreneurial team formation strategy is to seek teammates who possess complementary resources. Aldrich and Kim (2007) contrasted team formation based on

interpersonal relations (e.g., homophily) with formation based on 'rational' means such as complementary expertise. Perhaps the most important resource seeking strategy for entrepreneurial teams is complementary knowledge (Lazar et al., 2020). A common idea in this regard is that resource seeking strategies that produce cognitively heterogeneous teams lead to higher performance (Foss et al., 2008; Jin et al., 2017). This view fits with evidence that although forming teams by homophily is common for entrepreneurs it may hinder performance. McDonald and Westphal (2003), for instance, found that managers are likely to turn to friends and those with whom they share similar beliefs and opinions in order to affirm their own judgments. They found that this tendency was dysfunctional because seeking affirmatory views impedes learning and adaptation. Other evidence suggests that the strong cohesion and relationships fostered by forming a team by homophily are more important to performance than the expertise diversity that comes from resource seeking (Chowdury, 2005; Schoet et al., 2013). Mehra and colleagues (2006), for example, found that the leaders of high performing teams tended to be centrally located in friendship groups, providing reputational and resource benefits.

A third way to form the entrepreneurial team is through a hybrid or "dual" team formation strategy. Here, founders select teammates based on interpersonal attraction *and* resource seeking. Shah et al (2019) found that high performing entrepreneurial teams form based on expertise complementarity and shared values. Similarly, Forbes et al. (2006) found that technology-based spin-out ventures add new members ad hoc based on homophily or complementary resources.

Despite this vast literature, we do not know how team formation affects opportunity evaluation. To explore its influence, we developed an agent-based model.

4. Model

4.1. Agent-based modeling of entrepreneurial processes

To date simulation methods have not been widely used in entrepreneurship research. However, scholars have called for the use of simulation to develop behavioral models of the entrepreneurial process that complement models developed through other methods (McKelvey, 2004; Welter et al., 2016; Davidsson, 2015). And the use of simulation in entrepreneurship is growing (e.g., Keyhani & Lévesque, 2016; Mauer et al., 2018; Welter & Kim, 2018).

We build on a rich tradition in social science of building theory via computational simulation (see Axelrod, 1997; Davis et al., 2007; Epstein, 2006). This approach entails creating a computational representation of the phenomenon being studied by operationalizing concepts based on clear theoretical assumptions and building computational algorithms that reflect a specified theoretical logic (Davis et al., 2007). Because creating a computational representation requires clear specification of concepts and the rules by which they interact, it can improve researchers' understanding of concepts and the causal mechanisms that connect them (Davidsson, 2015). Moreover, once built the computational representation provides a platform for theoretical experimentation (Csaszar, 2019). The ability to vary concepts, values and assumptions, enables researchers to explore, elaborate or extend the focal theory.

Here, we use agent-based modeling due to its distinct advantages for simulating entrepreneurial processes (see McMullen & Dimov, 2013). As McMullen and Dimov (2013) argue, entrepreneurship is a multi-level process of information integration that begins with an individual but eventually involves multiple agents who must interact to make and shape judgments and beliefs, engage in social negotiation, and marshal collective action (McMullen & Dimov, 2013: 1492). Agent-based modeling is ideal for simulating such processes. Agent-based models typically involve heterogeneous, boundedly rational agents adapting to their

environments and interacting in ways that create emergent collective behaviors (Epstein, 2006). Applied to the present research, agent-based modeling allows us to exercise tight control over agents' limited cognitive capability to evaluate opportunities, experiment with alternate theoretically-specified ways of forming entrepreneurial teams, and examine how these processes interact with contextual factors such as team resources and task structure to influence performance.

Of course, as Knudsen, Levinthal and Puranam (2019: 1-2) recently remarked, a model is a model; it "is inevitably a 'small-world' representation of a more complex underlying reality". Computational models may lack the rich description provided by field observations or case studies. In contrast, the aim of modeling is to provide "a simplified picture of part of the real world" (Lave & March, 1993: 3) that is simpler than the world it represents but powerful enough to derive important insights. True to this spirit, our model does not seek to capture all the features of collective evaluation by entrepreneurial teams. Rather, we aim to represent the core tensions entrepreneurs face when they come together to evaluate opportunities. Our model and experiments clarify the theoretical mechanisms of a social cognitive entrepreneurial decision process, providing the basis for a generative theory of collective opportunity evaluation.

4.2. Overview of the model

Our model represents teams evaluating opportunities in a staged decision process. Teams comprise multiple individual agents, representing entrepreneurs, who provide estimates of an opportunity's value. The decision process begins with an opportunity arising in the environment and agents attempting to learn about it to improve the accuracy of their judgments of its value, although learning and accuracy are restricted by resources and agents' limited cognitive capability. A lead entrepreneur then emerges and forms the team — the collective of agents whose estimates contribute to the final decision to accept or reject the opportunity. We also

experiment with an alternative process whereby the team is formed *before* entrepreneurs learn about an opportunity. Finally, the team makes its decision by using a group decision rule to accept or reject the opportunity. The decision process is repeated over sequences of opportunities of various types, as described below. At the end of the simulations, we measured performance as the total value accumulated from seized opportunities, which reflects the performance potential of the team's decisions. Performance reflects the ability to select positively-valued opportunities (avoiding Type I errors) and reject negatively-valued ones (avoiding Type II errors). Figure 1 provides a schematic overview of the working of the model for each decision period, *t*, i.e., each opportunity evaluated. Table 1 summarizes the model's components.

Below, we describe the components of our baseline model, before examining variations of our assumptions and assessing robustness. The main elements of the model are: (1) a task environment that defines the actions possible for agents; in our model, the environment comprises varying types of opportunity that agents evaluate and can seize or reject, (2) agents' representation of the task environment, which in our model concerns individuals' knowledge related to a given opportunity and their judgments of its value, (3) choice processes, specifying how agents form the evaluation team and how they aggregate individuals' evaluations to make a collective decision to accept or reject an opportunity.

[Figure 1 and Table 1 about here]

4.3. Task Environment: Opportunities

We model the opportunity environment as a configuration space, based on the evolutionary approach to modeling technological change (e.g., Kauffman et al., 2000; Nelson & Winter, 1982). According to this view "the world of potential technological innovations can be conceived of as a landscape, with each potential position on the landscape corresponding to a particular configuration of components" (Aharonson & Schilling, 2016: 82). This view fits with

the idea that opportunities are "a set of environmental conditions" (Dutta and Crossan, 2005: 426), created by changing configurations of technological and market conditions, that create the potential for a profitable new course of action.

We build on this approach to simulate a task environment comprising opportunities that agents evaluate. We represent an opportunity as a binary bit string (e.g., '0110'). Binary strings are a widely accepted representation of information (after Shannon, 1948) and are commonly used to represent choice alternatives (e.g., Levinthal, 1997) and technological innovations (e.g., Frenken et al., 1999). In the present case, each bit can be thought of as a particular characteristic of the opportunity (e.g., its technological features, market features, etc.). We refer to the bit string as the *opportunity type*. An opportunity type is thus simply the combination of cues concerning the characteristics of a given opportunity. We treat the task environment as exogenous to agents. Table 2 provides a simplified example. In the model, opportunity types and individual types (see below) are strings of length 10. The combination of numbers in the binary string can be viewed as a particular position on the opportunity landscape. For each position, there are numerous adjacent technological possibilities. The similarity of or distance between two opportunities can be calculated as the Hamming distance (for a related example, see Frenken et al., 1999). For the example in Table 2, the Hamming distance between the first and second opportunities is one since they differ only on one characteristic. Using binary strings in this way is consistent with the idea that entrepreneurs use exogenous cues from the environment concerning possible combinations of technological and market features to build a picture of an opportunity and evaluate its potential (Baron & Ensley, 2006; Dutta & Crossan, 2005).

[Table 2 about here]

We furnish each opportunity with an *opportunity value.* Opportunity value is a real number that can be positive or negative, indicating respectively the potential returns or losses the

opportunity would yield if seized. Opportunity value is drawn from the uniform distribution $U(-5, 5)$. Agents use an opportunity's type as a signal of its worth as they evaluate its particular combination of features. This approach is in line with empirical observations that "the evaluation of the potential value inherent in a business opportunity relies on subjective judgments regarding different characteristics of an identified opportunity" (Gruber et al., 2015: 207). However, in our model, an opportunity's type and value are independent and unrelated, meaning that similar opportunity types can yield gains and losses of varying magnitude. We achieve this by generating these numbers from random distributions.

These two features of the task environment — the independence of opportunity types and the independence of an opportunity's type and its value — ensures that certain types of opportunity are not inherently more valuable than others, in line with evidence that existing combinations of technological or market characteristics are not necessarily accurate predictors of an opportunity's value (Denrell et al., 2003). We thus create a task environment that is dynamic and uncertain, consistent with the view that the space of technological and market possibilities that entrepreneurs face is a "dynamic, constantly evolving landscape" (Dimov, 2010: 1123).

4.4. Agents' representation of the task environment: Evaluations and learning

4.4.1 Agents' evaluations

The goal of agents is to select profitable opportunities in the task environment and reject unprofitable ones. To do so, agents evaluate the potential gains/losses of opportunities. Focussing on the gain/loss dimension of opportunity evaluation rather than on multiple dimensions (e.g., feasibility, see Scheaf et al., 2020) allows us to concentrate on how judgments are integrated at the team level.

Accurate evaluation at the team level depends on agents' individual judgments and the group-level processes of team formation and aggregation of individual judgments. At the

individual level, agents do not know the characteristics or value of an opportunity and must estimate value based on imperfect knowledge and probabilistic error. To model individual evaluation we build on research showing that entrepreneurs evaluate opportunities using their existing related knowledge (Haynie et al., 2009; McKelvie et al., 2011; Mitchell & Shepherd, 2010; Wood et al., 2014). Knowledge relatedness concerns "the degree to which the knowledge required to identify, evaluate, and exploit an opportunity is similar to the knowledge the entrepreneur already possesses" (Wood et al., 2014: 257). Building on this idea, we equip agents with an *individual type* that reflects their representation of opportunity types. In the model, individual type is a bit string where each binary bit can be thought of as an individual's representation concerning features relevant to an opportunity, such as technological or market features. Consistent with the nature of opportunity evaluation, our agents take a first person-perspective in the sense that they use their idiosyncratic knowledge to make judgements about the potential value of pursuing an opportunity. These judgments are then integrated across the team to make a judgment about the value of pursuing the opportunity for the team. Conceived thus, agents (and teams) use their own knowledge to discern the potential value of pursuing a potential opportunity.

At the beginning of the simulation, we assign each agent a randomly generated individual type. This random component ensures that entrepreneurs are heterogeneous in terms of their human capital resources (Shepherd & Williams, 2014), concerning specifically the knowledge they use to evaluate opportunities. We assume that agents evaluate opportunities sequentially, one at a time, in line with research showing that entrepreneurs have limited attentional capability which makes it difficult to assess multiple opportunities simultaneously (Shepherd et al., 2017).

The accuracy of individuals' estimations of an opportunity's value depends on what we term *cognitive distance*, i.e., the distance between their individual type and the opportunity type

at hand. We measure cognitive distance as the Hamming distance between the respective bit strings. Each individual formulates an estimation that we simulate with a random number drawn from a normal distribution, centred on an opportunity's real value, with a standard deviation equal to the cognitive distance (cf. Csaszar & Eggers, 2013). If cognitive distance is 0, the estimation is exact. When the cognitive distance is greater, the estimation is more likely to be further away from the real value. The accuracy of agents' judgments is thus a probabilistic function of their relevant existing knowledge (Sah & Stiglitz, 1986), with cognitively distant opportunities being more difficult to evaluate accurately (Gavetti, 2012; Shane, 2000). Hence, accuracy reflects the degree of alignment between agents' existing knowledge and the combination of signals concerning technological or market events for the opportunity type. While such structural alignment is often considered part of opportunity recognition (see, e.g., Grégoire et al., 2011), we assume here that it also carries over to the evaluation phase since cognitive processes are interrelated in these nested phases of entrepreneurial action (Grégoire et al., 2010; Shepherd et al., 2007; Wood et al., 2012).

4.4.2. Agent's learning

As agents assess an opportunity they can learn and adapt their knowledge. Hence, agents' knowledge is not static but rather changes over time in response to the task environment. Learning is important to the model because it enables us to examine the challenges teams face when evaluating opportunities in a cognitively dynamic world with limited resources (Haynie et al. 2009). We model learning by allowing individuals to reduce their cognitive distance to the current opportunity type. In this way, learning about a given opportunity creates a degree of specialization or path-dependency (Levinthal & March, 1993). However, because the type of a given opportunity is uncorrelated with the type of previous opportunities, for our agents learning

the characteristics of one opportunity does not necessarily provide the basis for evaluating subsequent ones accurately.

Importantly, we assume that opportunity learning (i.e., how many bits of agents' individual type they switch to match the current opportunity) depends on available resources. Entrepreneurs face important constraints in terms of the time, energy and information processing capacity they have to learn about a given opportunity (Haynie et al., 2009). We allocate resources to pools of agents that we term networks. These networks can be viewed as the social networks of entrepreneurs with differing human capital resources (see, e.g., Aldrich & Kim, 2007; Davidsson & Honig, 2003). In the model, entrepreneurs form their teams by selecting members from their network. We initially simulate networks comprising 20 individuals, representing a small core network of contacts (Cross et al., 2002). In robustness checks we examine larger networks (e.g., *N=100*) consistent with the size of small-world social networks (Aldrich & Kim, 2007).

Each unit of resource enables an agent to switch one bit of their individual type to match the corresponding bit of the focal opportunity type. Resource constraints limit how many agents are able to learn and how much they learn about an opportunity. We simulate the full range of learning resources, from zero (agents are unable to adapt their knowledge to the opportunity environment) to maximum (all agents are able to change their knowledge to match the current opportunity). Thus, the learning resources of the network are between 0 and $bit\ string\ length \times network\ size$ (*10* × *20* in the baseline), i.e., the maximum amount of resources necessary if all individual types are entirely different from the opportunity type (*bit string length = maximum cognitive distance = 10*). Simulating this range allows us to examine how variations in learning resources moderate collective decisions. The supply of resources is fixed over time. Each network has the same amount of resources for each opportunity they

evaluate, irrespective of previous performance. This assumption is consistent with evidence that learning capability is relatively stable over time (Anderson et al., 2009; Foss et al., 2008; Wiklund & Shepherd, 2003). For ease of interpretation, we show resources as proportions, from 0 to 1, where 1 represents the maximum amount of resources needed for all agents to learn fully.

To implement resource constraints in the model, learning resources are allocated probabilistically, meaning that every agent has some chance of reducing its cognitive distance. The shorter the cognitive distance between agents' type and the focal opportunity type, the more likely they are to move closer to the opportunity type. Hence, agents who are knowledgeable about a given opportunity are more likely to learn and increase their accuracy than less knowledgeable agents (Shane, 2000). After learning, agents make their individual estimates.

4.5. Choice process: Team formation and aggregation of individual judgments

Next, agents form the team. We conceive team formation as an endogenous process whereby entrepreneurs establish the social and cognitive structure of the team from their wider social network (Balkundi & Harrison, 2006). In our baseline model, we assume that agents learn about and appraise opportunities prior to the formation of the entrepreneurial team. The lead entrepreneur then initiates the search for team members from their network based on what members already know about the focal opportunity prior to joining the team. Teams pursuing specialized technological ventures often form in this way, as lead entrepreneurs select members based on their knowledge pertaining to a specific opportunity (Clarysse & Moray, 2004; Shah et al., 2019). In these situations, agents' evaluations are formed relatively independently of their involvement in the team — their evaluations precede formation of the team (Lazar et al., 2020). Accordingly, we term this baseline process *learn first.* We also experimented with an alternative team formation sequence, where agents learn about a focal opportunity *after* joining the team. This sequence reflects situations where the entrepreneurial team originates from a lead

entrepreneur putting together a team to evaluate the focal opportunity, as in our opening Netflix example (see also, Forbes et al., 2006). In these situations, entrepreneurial leaders hand-pick a small team of individuals to focus on the opportunity at hand — team formation precedes learning and team members are able to focus their attention and resources on the opportunity. We term this alternative a *learn after* process (see Figure 1).

Lazar et al. (2020) distinguish two stages of entrepreneurial team formation, namely the origin and formation strategy of the team. We model these two stages in terms of: (i) the emergence of a lead entrepreneur as the team's origin, whose function is to recruit others to the team and aggregate their evaluations and (ii) the selection of others into the team by the lead entrepreneur to provide multiple evaluations as the basis for action. Conceived thus, the lead entrepreneur is emerging from his/her social network and recruiting teammates from that network (see also Aldrich & Kim, 2007). Figure 2 illustrates our theorizing of these processes. We calculate the lead entrepreneur for each opportunity evaluated, meaning that the lead entrepreneur may change over time. Thus, our model can be viewed as representing different leaders forming potentially different teams to evaluate different opportunities, consistent with the emergent and dynamic nature of entrepreneurial teams (Lazar et al., 2020; Forbes et al., 2006).

[Figure 2 about here]

4.5.1. Origin of the team: The lead entrepreneur

The origins of entrepreneurial teams can be traced to particular individuals who act as 'ringleaders' to build the team endogenously (Lazar et al., 2020; Shah et al., 2019). We term these individuals lead entrepreneurs. Lead entrepreneurs can be founders who bring in known associates to help evaluate and shape a business idea (Clarysse & Moray, 2004). Shah et al. (2019) found that a key task for lead entrepreneurs is to recruit colleagues to assess the potential of technology related ventures. In doing so, the lead entrepreneur is seeking to "resolve the

social space" (Kozlowski & Ilgen, 2006: 105); that is, to create social structure to guide collective choice and mobilize collective action. In our model, the lead entrepreneur does this through a vital information aggregation role; that is, collecting evaluations from others in their network and aggregating them to estimate the value of an opportunity. Whereas scholars sometimes distinguish between team formation through entrepreneurial leadership or a more emergent process (Lazar et al., 2020), in our model team formation involves elements of both entrepreneurial leadership (i.e., someone has to actively seek others to join the team) and emergence (i.e., the team comes together based on socio-cognitive and structural relations).

To examine how the lead entrepreneur emerges we build on research on leadership and networks, which suggests that leader emergence is a relational process contingent upon social dynamics (Carter et al., 2015). We build on this view to posit that who becomes the leader of evaluation teams depends on their cognitive status, i.e., individuals' cognitive position in their network and in relation to the opportunity environment. Specifically, we propose and test three ways lead entrepreneurs emerge.

We first examine the effectiveness of a randomly selected leader. Our approach here is similar to the one taken by Aldrich and Kim (2007). They simulated the emergence of entrepreneurial teams by comparing random networks with networks that were more structured, namely small world networks and scale free networks. The assumption of this approach is not that entrepreneurs go randomly about their activities. Rather, the idea is that by considering a world "without order or design" (Aldrich & Kim, 2007: 150) researchers can examine the extent to which alternative, theoretically specified social structures and processes vary significantly from this baseline. Including a random leader in our model provides a baseline against which we compare the effectiveness of the other types of lead entrepreneur we model. To implement the *random* lead entrepreneur, for each opportunity evaluated we select an individual randomly from

the focal network to act as the lead entrepreneur. For this leader, there is no necessary correspondence between his/her knowledge and either the characteristics of the opportunity being evaluated or his/her network.

The second way that lead entrepreneurs can emerge is via expertise. Decision-making teams often convene around individuals who are knowledgeable about the task at hand and this informal leadership role may rotate to whichever individuals possess the requisite expertise (Friedrich et al., 2009). This type of leader can be considered a rational basis of leader emergence (Aldrich & Kim, 2007). However, the uncertain nature of opportunity evaluation means that building a team around expertise regarding future events is problematic. Because opportunities are future events that are unknowable in advance, managers cannot reliably judge a priori whose knowledge is closest to an emerging opportunity and may only know who is best placed to judge an opportunity with hindsight (Haynie et al., 2009). In such circumstances, decision makers may look to experts whose previous judgments have proved correct because past expertise provides a clearer and stronger signal of expertise than expertise concerning future events (March, 2006). This idea fits with evidence that lead entrepreneurs often emerge based on their prior experience (Iacobucci & Rosa, 2010; Lazar et al., 2020; Ucbasaran et al., 2003). We simulate the *expert* lead entrepreneur by assigning this role to the agent with the lowest cognitive distance from the previous, actually observed, opportunity (see Figure 2).

Third, we examine the effects of having the most *socio-cognitively central* individual as the lead entrepreneur. A considerable volume of research shows that leaders emerge based on social network structure or social relations (Carter et al., 2015). Research on social identity, for instance, attests to the effects of prototypicality on team formation and the emergence of group leaders (Hogg, 2001). This research shows that the most prototypical members – those whose knowledge, attitudes and other relevant characteristics are most typical of a group – tend to take

the lead in group decisions made under uncertainty (van Knippenberg et al., 2000). Groups are also more likely to endorse the views of their most prototypical member and weight their inputs most heavily (Hogg, 2001). Shalley and Perry-Smith (2008: 34-35) describe the status of such individuals in terms of socio-cognitive centrality, the position of individuals in a social network based on being most similar to others in their knowledge or other cognitive characteristics. They observe that "when members are sociocognitively central, they are in the enviable position of being able to validate other member's knowledge and perspectives while at the same time, the focal member's knowledge and perspectives can be validated by others". We theorize that such individuals may be well-positioned to aggregate others' evaluations.

We implement socio-cognitive centrality based on what we term *social distance*, which is measured as the Hamming distance between individual types. More precisely, the most central individual is the one whose individual type has the shortest average social distance from every other member's type in their network. As Figure 2 shows, this position represents a lead entrepreneur emerging based on their cognitive centrality in their network.

4.5.2. Team formation strategy: Homophily/heterophily

Once the lead entrepreneur emerges, he/she forms the team to gather evaluations from other members of his/her network. We theorize and test two ways leaders can do this, based either on homophily or resource seeking through heterophily, since these are two dominant formation strategies for entrepreneurial teams (Lazar et al., 2020).

In our model, when building the team based on *homophily* the lead entrepreneur includes the four members closest to him/herself in terms of social distance (see Figure 2). Homophily in the model thus concerns cognitive homophily, i.e., the preference for affiliating with those who have similar knowledge and attitudes to oneself (McPherson et al., 2001). In the present case, cognitive homophily involves lead entrepreneurs selecting teammates who share similar beliefs

(i.e., have similar individual types). For instance, lead entrepreneurs might select others with similar technological or market knowledge, yielding a pool of related and specialized expertise (Clarysse & Moray, 2004). This strategy is in line with evidence that entrepreneurs come together based on similar attitudes and beliefs (Parker, 2009), common knowledge (Foss et al., 2008), shared content-related knowledge (de Mol et al., 2015), and mutual understanding of venture-related issues (Beckman, 2006).

As noted above, an alternative team formation strategy is to seek individuals with complementary rather than similar knowledge (Forbes et al., 2006; Lazar et al., 2020). Such a resource seeking team formation strategy typically entails selecting members who have non-overlapping knowledge, skills and attitudes, since it is these cognitive characteristics that bring diversity and expertise to the team. For instance, leaders may seek out members with complementary education to help evaluate opportunities (Davidsson & Honig, 2003) or those with diverse industry knowledge (Mosey & Wright, 2007). Shah et al. (2019) observed that in spinouts in the disk-drive industry lead entrepreneurs deliberately searched for individuals with complementary functional knowledge to create diverse teams.

Accordingly, we simulate a resource seeking team formation strategy based on *heterophily*, i.e., seeking out views from others who are different to the self (Rogers & Bhowmik, 1970). In the model, when forming the team based on heterophily, the lead entrepreneur includes the four members of his network who are furthest from him/herself in terms of social distance (see Figure 2). This heterophilic tendency reflects a desire to affiliate with those whose knowledge and assessments are different from the leader's own (Kilduff & Tsai, 2003). This strategy thus represents situations where lead entrepreneurs turn to cognitively dis/similar others not necessarily because this guarantees any performance advantage but because cognitive diversity is seen as intrinsically valuable (Shah et al., 2019).

Given the preference for homophily, the tendency for heterophily may seem antithetical to team functioning. However, many recent advances in network theory stem from ideas concerning heterophily (Kilduff & Tsai, 2003). For instance, Shipilov, Li and Greve (2011) found that managers seek ties with heterophilous partners to procure unique information and resources. Studies of network dynamics show that heterophily can provide access to complementary skills in collaboration networks (Xie et al., 2016). Parker (2009) found that heterophily can aid venture performance by producing teams comprising individuals with different levels of optimism.

We set the size of the entrepreneurial team at five persons. Using either homophily or heterophily, leaders recruit four individuals in addition to themselves. New venture teams are typically small teams (e.g., Cooney, 2005). In Jin et al's (2017) recent meta-analysis of entrepreneurial teams, across 52 studies average team size ranged from 2.11 to 9.73. Hence, setting team size as 5 seems a reasonable starting point. In robustness checks we examine variations in team size.

4.5.3. Group decision

Finally, the lead entrepreneur aggregates the evaluations of the individuals comprising the team (G) to form its collective evaluation and they decide whether to accept or reject the focal opportunity using majority rule as the group decision rule. We implement majority rule since it is the most common decision rule in all types of groups, including teams (Csaszar & Eggers, 2013; Hastie & Kameda, 2005). Majority rule is a common way for groups to make decisions when it is difficult to assess which alternative is correct (Fang et al., 2010), including management teams making strategic decisions (Amason et al., 1995; Cyert & March, 1963). Majority rule can be viewed as either a formal voting system or less formally as the team acting based on the prevailing sentiment of its members. To implement majority voting, the leader collects votes

from team members $g \in G$ $vote_g = \begin{cases} 0 \; if \; estimation_g < 0 \\ 1 \; if \; estimation_g \geq 0 \end{cases}$. The opportunity is accepted if $\sum_{g \in G} vote_g > \frac{|G|}{2}$. In robustness checks we vary the group decision rule.

5. Results

We organize the results around a series of plots that illustrate the model's behavior. Our key findings are that: (1) teams with socio-cognitively central lead entrepreneurs perform best, (2) homophily is a surprisingly effective means of forming an entrepreneurial team when the team forms after individuals have learned about a focal opportunity, and (3) heterophily is the best performing team formation strategy when the team forms before agents have learned about the opportunity. To control for the stochasticity of opportunities and individuals, we repeated the simulations over 1,500 sequences of 100 opportunities. We analyzed the statistical significance of the differences between the curves shown in the plots, running paired sample t-tests to compare the distributions. All differences highlighted below are significant at $p < 0.0000005$. The data shown is the average of the 1500 repetitions.

5.1. Teams with socio-cognitively central lead entrepreneurs perform best

We begin by comparing the performance of lead entrepreneurs. Figure 3 plots the performance of the three types of lead entrepreneur (random, expert, and socio-cognitive centrality). This figure can be viewed as lead entrepreneurs with different socio-cognitive positions evaluating opportunities by selecting teammates with varying human capital resources for opportunity learning. For initial purposes, for Figure 3 team formation is based on homophily, since homophily is often the default means by which entrepreneurial teams emerge endogenously (Lazar et al., 2020; Ruef et al., 2003).

The main observation from Figure 3 is that there is a striking advantage for socio-cognitively central lead entrepreneurs. Occupying a cognitively central position allows the lead

entrepreneur to coordinate collective opportunity evaluation more effectively than either experts or random leaders whose position is not tied to their cognitive status. This result suggests that when the nature and value of an opportunity is uncertain entrepreneurs would be better served by a leader who is cognitively central than by a leader who is appointed based on his/her expertise related to previous opportunities, as per the expert lead entrepreneur modelled here. Both types of leader outperform the random leader.

[Figure 3 about here]

It is instructive to reflect on why cognitive centrality gives an advantage. As agents in the network learn about the focal opportunity, there is a partial collective convergence upon the focal opportunity type. As agents converge cognitively, the social distance between them closes. And since the most socially central individual is the one with the shortest social distance on average from all other members of the network, it becomes likely that he/she will be close to this cluster of converged individuals. Hence, the socially central lead entrepreneur emerges close to the shifting center of gravity in his/her network, which in turn locates him/her in the proximity of the focal opportunity that is pulling individuals together. As a result, using the most socio-cognitively central agent means that the team draws on a more adaptive sample of the changing knowledge base. For lead entrepreneurs operating in an uncertain opportunity environment, the advantage of being central comes from being in touch with the knowledge of the collective.

A second observation from Figure 3 is that the advantage of lead entrepreneur centrality is contingent upon learning. At low levels of learning, the differences between alternative lead entrepreneurs are negligible but as learning increases the advantage of centrality increases, although the performance of all lead entrepreneurs converges at the highest levels of learning. These effects reflect the fact that moderate levels of learning create the greatest variation among individuals' evaluations of an opportunity. At low levels of learning, the knowledge base of the

network remains relatively static (i.e., uncorrelated with the opportunity environment) and collective estimates of a new opportunity are similar irrespective of who leads the collective evaluation process. The converse state of affairs characterizes high levels of learning; when agents learn greatly, the network converges upon the current opportunity environment and estimates are again similar irrespective of whether the lead entrepreneur is the expert, most central, or random agent. Figure 3 shows, however, that the zone of divergence between the performance of lead entrepreneurs' is wide; that is, even small increases in opportunity learning create significant differences between types of lead entrepreneur and these differences persist until agents' learning is almost complete. These results demonstrate that the question of who is the lead entrepreneur is an important one across a wider range of conditions.

5.2. Homophily can be an effective strategy for forming an evaluation team

Next, we explore the effect of team formation strategy. Figure 4 plots the effectiveness of homophily and heterophily for the three types of lead entrepreneur.

[Figure 4 about here]

The most outstanding observation from Figure 4 is the dominance of homophily over heterophily. In a dynamic opportunity environment, even the worst performing lead entrepreneur (the expert) when coupled with homophily outperforms the best performing lead entrepreneur using heterophily. This result runs contrary to the common view that homophily is commonplace but might not be conducive to the types of team composition that aid effective decision-making (Aldrich & Kim, 2007; McDonald & Westphal, 2003; Parker, 2009; Reagans et al., 2004). It is instructive to examine why homophily is advantageous in this context. As agents learn about opportunities, their knowledge begins to shift toward the current opportunity environment. By capturing individuals who are close to one another, homophily is more likely to capture a cluster of accurate evaluators, i.e., several individuals with low social distance from each other and low

cognitive distance from the current opportunity. In contrast, by seeking difference, heterophily may by chance capture individuals who are close to the current opportunity but is unlikely to capture a team of such individuals as required for a collective decision.

The contrast between homophily and heterophily is all the more surprising since it is commonly assumed that homophily is particularly dysfunctional in dynamic environments, where accessing diverse resources is often seen as prerequisite (e.g., McDonald & Westphal, 2003; Reagans et al., 2004; Hmieleski & Ensley, 2007). The reason that the advantage of homophily is particularly pronounced here is that the dynamic opportunity environment results in different configurations of knowledge within the network of agents. In our opportunity environment, at all but the lowest and highest levels of learning a high degree of heterogeneity is maintained as agents seek to adjust to the diverging opportunity types arising. This greater heterogeneity amplifies the difference between homophily and heterophily, making the contrast between a team comprising similar expertise and a team of dissimilar individuals with varying cognitive distance more pronounced.

5.3. Heterophily is best when agents learn after the team forms

Next, we explore the effects of varying the team formation sequence, based on the two contrasting views described above. Teams can either form after agents have already learned about the focal opportunity ('learn first') or can form before agents learn, meaning that the team concentrates on learning about the opportunity ('learn after'). Figure 5 shows the results of this experiment. Immediately apparent is that when agents learn after team formation heterophily outperforms homophily. Thus, we see a reversal of the dominance of homophily shown in Figure 4 for the learn first situation. In Figure 5, all forms of heterophily outperform all forms of homophily. Moreover, the advantage of heterophily persists across most levels of learning, until the point at which the methods of team formation converge at high levels of learning. Also

notable is that when agents learn after the team is established it is the team formation strategy that drives performance; the status of the lead entrepreneur makes little difference.

[Figure 5 about here]

Why does this performance reversal occur? Recall first that the main corollary of the learn after sequence is that, by forming the team *before* learning occurs for the current opportunity, the team is naturally formed around agents whose knowledge base developed for the previous environment. The consequence of forming the team around this knowledge base is that it is likely that the lead entrepreneur will not initially have intimate knowledge of the new opportunity to be evaluated. Suppose now that a socio-cognitively central lead entrepreneur selects individuals for his/her team who are most dissimilar to himself/herself (shown as centrality-heterophily in Figure 4) and then allows those individuals to learn as much as possible given human capital constraints (i.e., learning resources). This heterophile strategy leads to the formation of a team that is initially more dispersed in terms of its members' knowledge, increasing the chances that some of those members are closer to the new opportunity, will learn more efficiently, and therefore evaluate the opportunity accurately. This result also tells us that heterophily can be an antidote to the danger of groupthink for entrepreneurial teams (cf. Chowdhury, 2005; Lechler, 2001). That is, choosing team members who initially have dissimilar knowledge helps to prevent too much convergence upon a given opportunity, meaning that the team retains greater cognitive diversity than teams formed through homophily, which can aid future decisions.

5.4. Extensions and robustness

We checked the robustness of our results to variations in our assumptions concerning team formation strategy, team and network size, and group decision rule. First, we examined the efficacy of a hybrid method of team formation that is part homophily and part heterophily,

representing leaders seeking to balance interpersonal attraction and resource seeking (Lazar et al., 2020). Using a hybrid method, the lead evaluator collects judgments from the two closest individuals and two furthest individuals from him/herself in terms of social distance, aggregating their votes along with his/her own. We found that for the cognitively central lead entrepreneur the hybrid method is significantly less effective than homophily, further illustrating the primacy of centrality-homophily. Interestingly, however, the results show that for randomly appointed lead entrepreneurs the hybrid method outperforms homophily and heterophily. This result suggests that a hybrid strategy may be more useful when lead evaluators cannot capitalize on their centrality or past expertise.

Second, we examined whether our results are contingent upon the adoption of majority rule or whether they hold for different group decision rules. To do so, we re-ran our analyses changing majority rule to an averaging rule, which has been touted as a means of providing accurate group estimates (Larrick & Soll, 2006). We obtained the same pattern of results with averaging as with majority voting: central leaders still outperform past experts and the effectiveness of homophily and heterophily depends on the team formation process.

Third, we re-ran our experiments with smaller and larger teams (n = 2, 3 and 8) and different sized networks (n=10, 50, 100). These variations do not affect the pattern of results; the reported rankings for different lead entrepreneurs and team formation strategies are the same. However, these variations change absolute performance quite intuitively. The larger the team, the higher the performance of all strategies. For smaller teams, the effect of a poorly-performing lead evaluator is greater than for larger ones. A larger team produces a wisdom of crowds effect, and a larger team relative to a smaller network offers a better use of learning resources. Larger networks result in more extreme versions of homophily/ heterophily, amplifying performance differences between these strategies.

6. Discussion

Conceptualizing opportunity evaluation as a collective process, we set out to examine how the formation of start-up and new venture teams affects their ability to evaluate opportunities. We showed that the origins of the team and the team formation strategy both influence opportunity evaluation. Based on the observation that entrepreneurial teams originate sometimes based on lead entrepreneurs' expertise and other times based on their socio-cognitive status, we show that teams led by entrepreneurs who are cognitively central in their network are more likely to be effective at evaluating opportunities. We further show that the most effective team formation strategy – recruiting others based on interpersonal similarity (i.e., homophily) or resource seeking (i.e., heterophily) – depends on learning, specifically whether the lead entrepreneur forms the team from agents that have already learned about the focal opportunity (learn first) or first recruits teammates who learn about the focal opportunity after joining the team (learn after). When lead entrepreneurs select team members who already know about the focal opportunity, the cognitive status of the lead entrepreneur is more important than the team formation strategy. In these circumstances, homophily is the most effective strategy. Conversely, when the team forms before entrepreneurs learn about the focal idea, not only is the team formation strategy more important than the status of the lead entrepreneur but heterophily is the best strategy.

6.1. Understanding opportunity evaluation as a collective process

A key contribution of our work is that it extends existing research on opportunity evaluation to account for the interdependent, team-based nature of opportunity evaluation. Scholars increasingly view the evaluation of opportunities as central to entrepreneurial activity but to date have largely viewed the phenomenon as an individual cognitive process (Haynie et al., 2009; Keh et al., 2002; Wood & Williams, 2014; Wood & McKelvie, 2015). Our work

complements this existing focus and opens up new possibilities that promise to change the direction of opportunity evaluation research by embracing its collective nature. Our work extends research on opportunity evaluation in three ways.

First, researchers have posited that opportunity evaluation reflects an individual's particular cognitive processes (Wood et al., 2012; Keh et al., 2002), their idiosyncratic knowledge (Haynie et al., 2009), and individual values (Shepherd et al., 2007). When the social dimension has been considered this has mainly been restricted to how entrepreneurs' assessments of opportunities overlap with stakeholders outside the venture such as investors (Wood & McKelvie, 2015). Our work extends current understanding of opportunity evaluation beyond these concerns. A basic contribution of our theorizing and modelling is that it illustrates the possibilities of using entrepreneurial teams as the unit of analysis for understanding opportunity evaluation. While researchers have called for such work (Keh et al., 2002; Shepherd, 2015), progress has been slow. Our work highlights that judgments of the value of opportunities can be an outcome of team processes, complementing research in the corporate context showing that teams decide what is technically feasible for an opportunity (Shepherd & Krueger, 2002). More generally, our work illustrates the importance of going beyond the individual to understand how entrepreneurs perceive and assess opportunities (see also Patzelt, Preller & Breugst, 2021).

Second, our theorizing and findings suggest that the cognitive characteristics and ability to assess opportunities effectively can fruitfully be conceived at the collective level. Foundational theories of entrepreneurship posit that the ability to recognize and evaluate opportunities depends on entrepreneurs having the cognitive characteristics necessary to value them (Shane & Venkataraman, 2000). Our analysis broadens the conception of what these properties entail to include not just the individual mental faculties to judge technological and market conditions (see Wood & McKelvie, 2015) but the ability to form a team that can do this.

Our findings suggest that team formation processes are instrumental to collective opportunity evaluation because they determine the cognitive composition of the team, thereby shaping whose knowledge is applied to evaluate opportunities. From this perspective, a vital skill for entrepreneurial leaders is the ability to act as a hub to gather information from the spokes of expertise in their network to build an accurate picture of the potential of an opportunity. Conceived thus, one's social network status and the ability to choose an effective team formation strategy should also be considered part of these cognitive characteristics. It seems that recognizing and accessing expertise is a vital part of the skillset of opportunity evaluators. Our analysis also points toward the importance of choosing an appropriate group decision rule as another cognitive competence. Research shows that individual decision rules are important to how opportunities are evaluated (Wood & Williams, 2014). Our findings show that the *group* decision rule adopted also matters to collective evaluation. Future research can build on our analysis to examine which group decision rules start-up teams use to integrate team members evaluations and to what effect.

Third, and overall, our work provides a new view of opportunity evaluation as a networked, relational and dynamic phenomenon. Opportunity evaluation is networked in the sense that, when undertaken as a team, it depends on lead entrepreneurs' cognitive status in their network and who they reach out to for additional judgments. When viewed in a networked world (see also Aldrich & Kim, 2007), the cognitive network status of the lead entrepreneurs who form evaluation teams takes on a particular importance. For instance, our findings suggest that socio-cognitive centrality (Shalley & Perry-Smith, 2008) can be an advantage for entrepreneurs evaluating opportunities collectively. Our analysis also provides a view of opportunity evaluation as a relational phenomenon. Our findings suggest that homophily might be beneficial for making collective opportunity decisions when teams form around entrepreneurs who have

already learned about a focal opportunity but that heterophily can be advantageous when recruiting people to learn about the opportunity at hand. This relational view encourages researchers to see opportunity judgments as constructed based on entrepreneurs' relationships with similar and dissimilar others. Finally, by incorporating the dynamism inherent in the exogenous formation and development of entrepreneurial teams (Lazar et al., 2020), our work extends understanding of the dynamism of opportunity evaluation beyond individual cognitive dynamics (cf. Wood & McKelvie, 2015) to include social dynamics. Specifically, our analysis shows how opportunity evaluations and decisions change as lead entrepreneurs select individuals into the team, variously applying interpersonal (i.e., homophily) or resource seeking (i.e., heterophily) strategies to form teams from a cognitive network that is itself changing in response to changes in the opportunity environment.

6.2 Directions for future research

Our theorizing and modelling provide a platform for a new wave of research on opportunity evaluation. We envisage three particularly promising directions.

First, there is a need to validate the findings from our simulations with data from the field. Researchers have used observation (Clarysse & Moray, 2006), surveys (Jin et al., 2017), and interview (Forbes et al., 2006) methods to identify how entrepreneurial teams form. These methods can be extended to examine how team formation shapes the evaluation process and outcomes. Our simulations highlight the importance of lead entrepreneurs, not necessarily as influencers of others (Renko et al., 2015), but as central coordinating agents who can effectively access and integrate multiple assessments. Field observations would help to validate our findings concerning cognitive centrality (Shalley & Perry-Smith, 2008), i.e., that cognitively central members of a network are more likely to emerge as lead entrepreneurs and that their position can influence how opportunities are evaluated. Case studies and interviews will be useful for

examining what other characteristics help lead entrepreneurs gather evaluations from others. Our results highlight the importance of network position but we need to know more about the network attributes that help entrepreneurs evaluate opportunities effectively. Social network analysis would be useful for examining how network connectivity and network range shape entrepreneurs' ability to identify and evaluate opportunities effectively. We know that certain network attributes disadvantage entrepreneurs in terms of innovation and growth (Burt, 2019) but how do these attributes affect the collective ability to recognize and evaluate opportunities?

Second, our analysis has barely scratched the surface in terms of understanding how social factors affect opportunity evaluation. Here we focussed on the challenge of harnessing and integrating multiple evaluations by forming a team, predicated on the idea that the advantage of having multiple evaluators comes from them having independent views. An interesting question is how our assumptions translate to the world entrepreneurs confront in their daily lives. Do lead evaluators manage to maintain this potentially advantageous independence of judgment among team members? Or does interaction among entrepreneurial team members lead to the type of cognitive convergence that can undermine a team's evaluation capabilities, as can be the case with other endogenously formed groups (Le Mens et al., 2018)? Another possibility is that certain individuals, perhaps lead entrepreneurs but also charismatic or expert entrepreneurs (see, e.g., Kacperczyk, 2013), exert unequal influence on how teams evaluate opportunities? Our model can be extended to study such interpersonal influence. Another question is how opportunity beliefs and evaluations emerge as a result of shared cognition. While measures of mental models and interviews have proved useful for studying shared cognition (de Mol et al. 2015), simulations can also be used for this purpose and our model again provides a platform for such work.

A third direction for future research is to extend our theorizing beyond the early-stage estimates of opportunity value that we studied here. While we focused on judgments of potential

gains and losses, there are important questions concerning how teams weight and combine the independent judgment criteria of gains/losses, desirability, and feasibility (see Scheaf et al., 2020). For start-up teams, what is regarded as personally desirable and feasible might become more about what the team regards as feasible and desirable rather than any one individual (cf. Shepherd & Krueger, 2002). Although we focussed on how teams combine individual judgments (see also Healey, Vuori & Hogkinson, 2015), it is easy to imagine that perceptions of desirability and feasibility and even potential gain are socially constructed as individuals share their motives, exchange market and technological information, and share business ideas. It would be fascinating to study the social dynamics of how these perceptions emerge at the collective level.

6.3 Limitations

It seems prudent to point out some limitations of our work. First, our model is not a fully featured model of individual-level opportunity evaluation. Our agents' evaluations comprised gain/loss estimates and their assessments did not factor in the feasibility of an opportunity, which research suggests is an important component of an opportunity's overall attractiveness (Scheaf et al., 2020). As noted above, a promising avenue for future inquiry is how individuals and teams combine gain/loss judgements with feasibility judgements. Second, although our model incorporated learning to simulate the cognitive dynamics of the entrepreneur-opportunity nexus, learning resources were static over time. This seems a reasonable starting point but future studies of such dynamics might fruitfully focus on how the resources of teams and ventures change over time and how this affects decisions and actions (cf. Haynie et al., 2009).

6.4 Conclusions

We have conceived opportunity evaluation as a team process rather than an individual one. From this perspective, and as our results show, the social-cognitive dynamics of team formation shape how entrepreneurs evaluate opportunities. Our findings demonstrate that the

cognitive status of the lead entrepreneurs who form entrepreneurial teams and the strategies they use to form the team both affect the ability to build an accurate picture of the value of opportunities. These processes matter because they determine whose knowledge is used to evaluate opportunities. We hope that our work inspires others to probe further into the social and cognitive processes that affect this vital stage of the entrepreneurial process.

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Table 1. Model Components and Values

Component	Definition	Value
	Task environment	
Opportunity type	A combination of characteristics representing an opportunity	10 bit binary string
Opportunity value	A positive or negative number representing returns or losses	[-5,5]
	Agent's representation	
Individual type	An individual's knowledge structure concerning features relevant to an opportunity	10 bit binary string
Cognitive distance	Hamming distance between individual and opportunity types	[0,10]
Learning resources	Resources employed to reduce cognitive distance (0 indicates no resource, 1 indicates enough resources if all individual types are entirely different from the opportunity type)	[0,1]
Individual estimation	Drawn randomly from a normal distribution, centered on the opportunity value; standard deviation is the cognitive distance	$N(\mu,\sigma), \mu \in [-5,5],\ \sigma \in [0,10]$
	Choice process	
Network size	Number of individuals in the larger network	20 (Ext.:10,50,100)
Team size	Number of individuals participating in the team decision	5 (Ext.: 2,3,8)
Social distance	Hamming distance between individual types	[0,10]
Lead evaluator		
Random	A randomly selected member of the larger network	-
Expert	The individual with the lowest cognitive distance from the previous opportunity	-
Central	The individual whose individual type has the shortest average social distance from every other member's type	-
Team formation		
Homophily	Lead evaluator includes the four members closest to him/herself in terms of social distance	-
Heterophily	Lead evaluator includes the four members furthest to him/herself in terms of social distance	-
Hybrid (extension)	Lead evaluator includes two members closest to him/herself and two members furthest to him/herself in terms of social distance	-
Group decision rule		
Majority rule	Each team member assigns one vote to an opportunity with an estimated positive value; team accepts opportunities receiving positive votes from more than half of its members	Accept, reject
Averaging rule (extension)	Each team member estimates the value of each opportunity and the team computes each opportunity's mean estimated value and accepts opportunities with a positive mean	Accept, reject
Performance	Sum of the values of opportunities accepted	

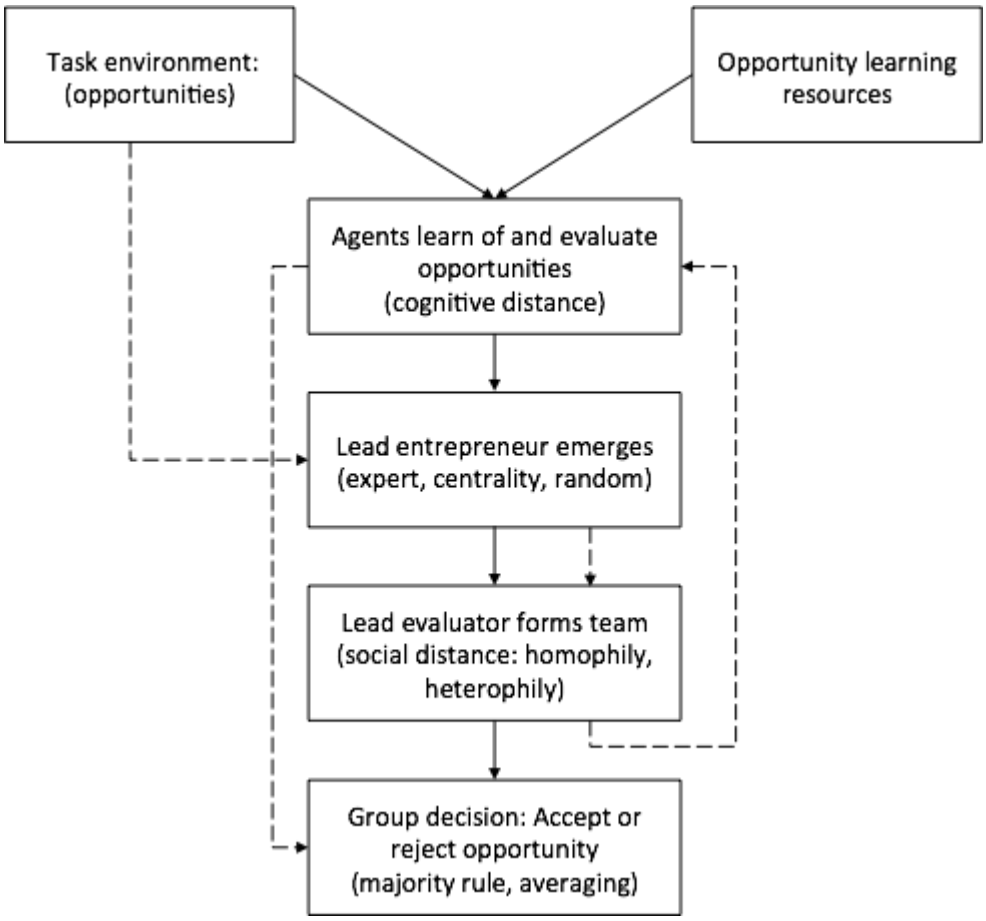
Note: Ext. (Extension) indicates values used for the extensions in sections 4.3. and 4.4.

Table 2. Examples of opportunity types

	X_1: Production	**X_2: Purchase**	**Opportunity type**
Opportunity 1: Custom baseball bats	Customized	Single	00
Opportunity 2: Ergonomic baseball bat	Mass	Single	10
Opportunity 3: Custom shampoo	Customized	Repeat	01
Opportunity 4: Dry shampoo	Mass	Repeat	11

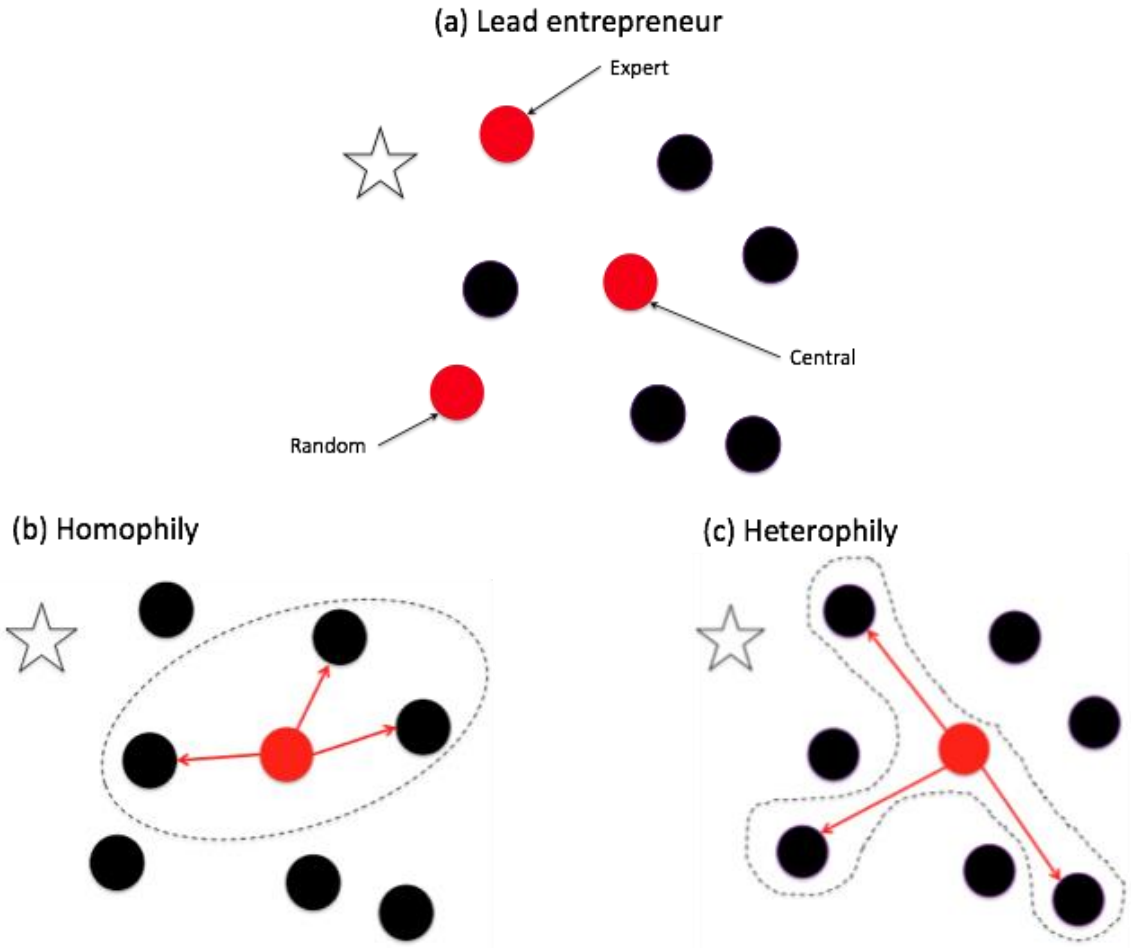
Note: In this simplified example opportunity types are represented by strings of two bits. In our model opportunity types are represented by strings of ten bits and the opportunity environment comprises 2^10=1,024 different opportunity types.

Figure 1. Process of team opportunity evaluation in each period, *t*



Note: Continuous lines represent the baseline model, where the team forms after agents learn about the opportunity at hand ('learn first'). Broken lines represent the alternative team formation process, whereby agents learn about the focal opportunity after the team forms ('learn after').

Figure 2. The formation of opportunity evaluation teams



Note: Circles represent individual agents and the star represents a previous opportunity known to agents. Distance between objects represents relative proximity in terms of knowledge. In panel (a) the expert is closest to the previous opportunity, the central agent is closest on average to all other individuals in terms of knowledge (i.e., lowest social distance), and for the randomly selected agent there is no necessary correspondence between his/her knowledge and opportunity types or other agents' knowledge. Under homophily (panel [b]) the lead entrepreneur (shown here as the most central agent) forms the team by including agents most similar to him/herself while under heterophily (panel [c]) the leader forms the team by including agents most dissimilar to him/herself.

Figure 3. Effects of lead entrepreneur on performance

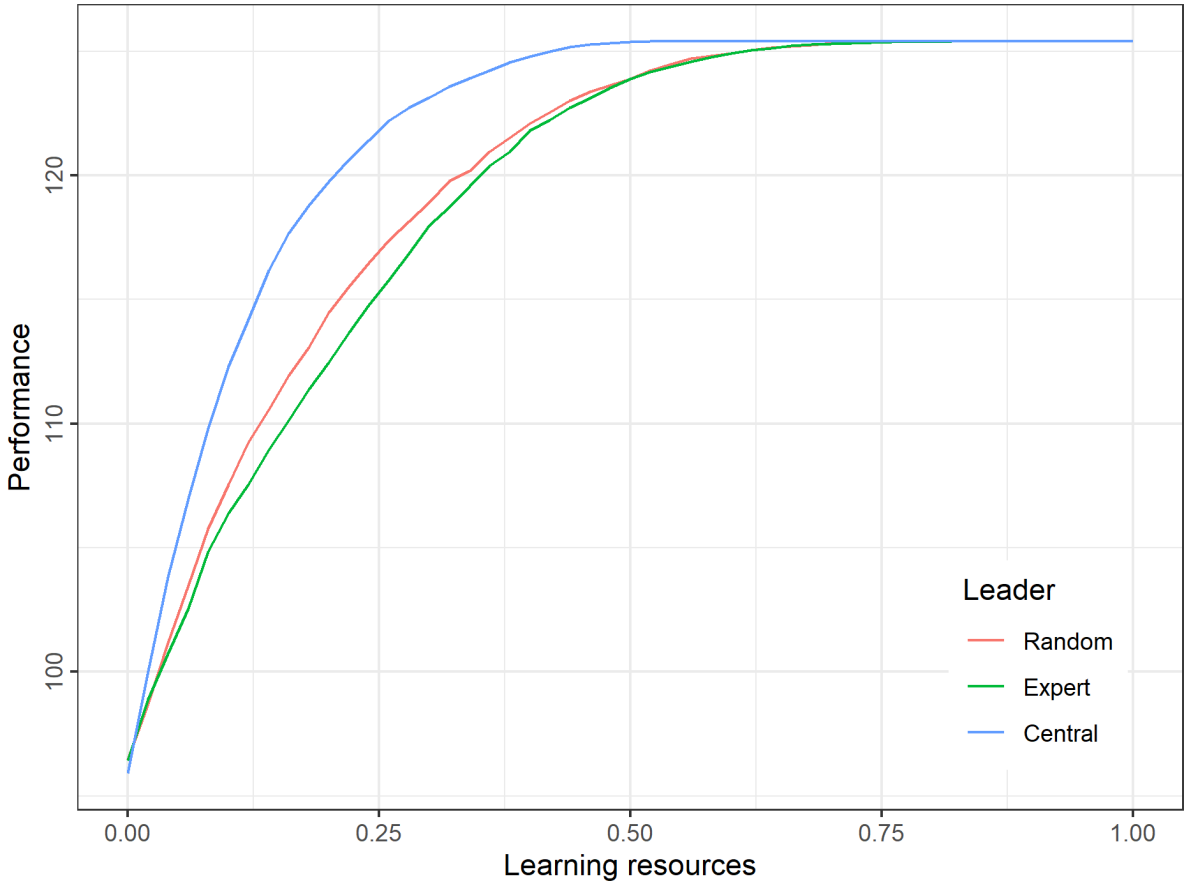


Figure 4. Effects of lead entrepreneur and team formation strategy on performance

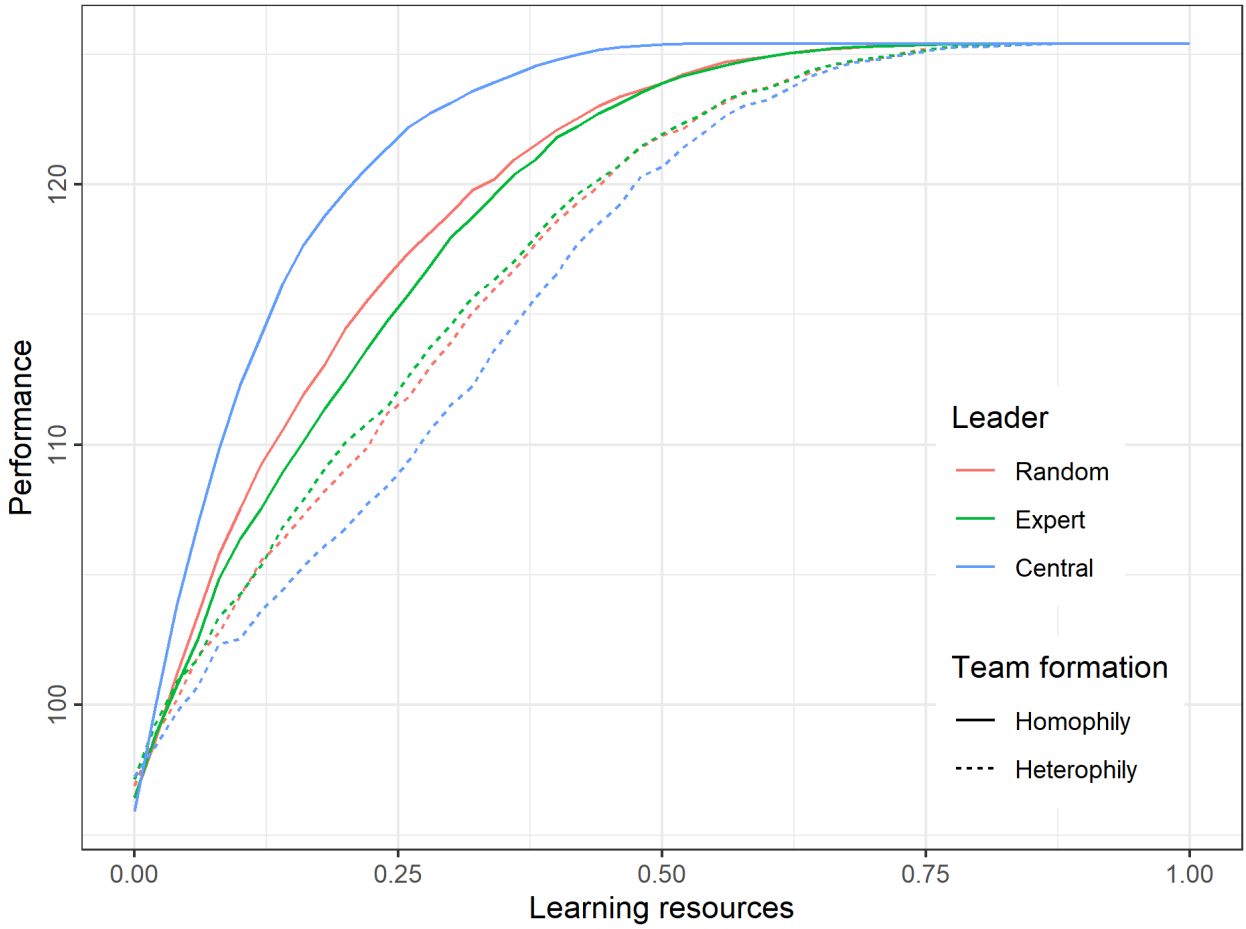


Figure 5. Effects of lead entrepreneur and team formation when team formation precedes opportunity learning