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Psychological Safety and Experimentation: Agent-Based Modeling Approach

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Introduction

Experimentation is an essential activity for contemporary firms intending continuous innovation and growth (Bojovic et al., 2018; Felin et al., 2020; Thomke, 2003). Experimentation is defined as “the use of models, prototypes, controlled environments, and computer simulations that allow innovators to reflect, improvise, and evaluate the many ideas generated in organizations” (Thomke, 2003, p. 6). Experimentation varies across industries, but it shares a commonality of trial and error learning. In particular, collaborative innovation requires experimentation to test and evaluate ideas many participants bring in (Chesbrough, 2010; Hartley et al., 2013).

Given the important role of experimentation in continuous and collaborative innovation, managers should build an organizational environment that facilitates employees' experimentation. In these environmental factors, practitioners and scholars have recently focused on psychological safety (Cannon & Edmondson, 2005; Thomke, 2020). Psychological safety is a shared belief within a team that the team is safe for interpersonal risk-taking (Edmondson, 1999). As one cannot foresee the result or avoid potential experimentation failure, employees are less likely to experiment if they believe they are unsafe for taking risks. Conversely, employees are more likely to experiment in a climate that allows taking risks (Naranjo-Valencia et al., 2017).

However, when we focus on the individual's experimentation and its consequences, we can see a dynamic relationship between psychological safety and employees' experimentation (Coutifaris & Grant, 2022). For example, if one receives a penalty for his/her failure in experimentation, he/she will feel less safe about taking risks and, hence, less likely to experiment at the next opportunity. This causal relationship between experimentation and demotivation is less examined. How does psychological safety emerge from the micro dynamics of experimentation and its consequences?

Research design

To investigate this research question, we develop the agent-based model to simulate individuals' experimentation and its consequences within an organization. The agent-based model is a method for studying systems composed of interacting agents (Secchi & Neumann, 2016). One deploys agents in the virtual space, defines interaction rules for the agents, and runs simulations under various conditions. This method can examine factors that are difficult to control within real organizations and thus is appropriate for the aim of this study.

This study develops an agent-based experimentation model based on the garbage can model (Cohen et al., 1972; Fioretti & Lomi, 2008; Herath et al., 2016). Our model comprises four agents: employee, idea, apparatus, and opportunity. The employee agents have two parameters: ability and motivation. The idea and apparatus agents have one parameter: difficulty and efficacy, respectively. These four agents move randomly and interact in the virtual space, representing an organization. When the four agents gather in the space, the employee tests the idea with the available apparatus at the opportunity. Then, the experimentation succeeds if the following condition is satisfied:

$$E(a) \times A(e) \geq I(d) \qquad (1)$$

where E(a), A(e), and I(d) denote the employee's ability, the apparatus's efficacy, and the idea's difficulty, respectively.

If condition (1) is not satisfied, the experimentation fails. Depending on the parameters set, the employee may learn from failure (his/her ability rises) or receive a penalty (his/her motivation drops).

When an employee, an idea, and an opportunity gather, the employee decides whether to hold or discard the idea. The decision depends on the employee's motivation; if the motivation is lower than the threshold, the employee discards the idea.

The simulation is composed of 100 of each agent type. At each simulation step, the agents randomly move within the organization and make decisions when the other agents gather around an employee. After 1,000 steps, the simulation is completed. Table 1 shows the parameters given in the simulation.

Table. 1 Parameter of the simulation

Parameter	Value
Number of agents:	
Employee	100
Idea	100
Apparatus	100
Opportunity	100
Initial motivation of employee	$N(50, 100)$
Initial ability of employee	$N(50, 100)$
Efficacy of apparatus	$N(0.8, 0.2)$
Threshold motivation to discard idea	40
Learning from failure (LFF)	{0, 20}
Penalty	{0, 20}

Result and discussion

Table 2 shows the results of the simulations. We ran simulations twelve times in each setting and calculated means by removing the data with the most and least experiments. The comparison between settings 1 and 2 revealed that employees' motivation decreased when receiving a penalty, and hence, employees discarded more ideas and less experimented. The comparison between settings 1 and 3 also showed that the success rate rose when employees could learn from failure. Moreover, setting 4 resulted in a high success rate, but innovation, the sum of succeeded ideas' difficulty, was lower than setting 3. This implies that a penalty does not impact the success rate but reduces innovation because the penalty increases idea discarding.

These results provide two theoretical implications to the psychological safety and experimentation literature. First, psychological safety in an organization can be conceptualized as the presence or absence of a penalty for failure and the resulting demotivation. Second, the suppression of experimentation due to low psychological safety can be conceptualized as increased idea-discarding due to decreased motivation. Moreover, our results provide practical implications; a penalty appears to increase the success rate but inhibits experimentation and discourages innovation. Blaming failure harms experimentation and innovation.

Table 2 Setting and result of the simulation

Setting			Result[a]						
No	Penalty	LFF	Experimentation	Success	Discarded	Mean ability	Mean motivation	Success rate	Innovation[b]
1	0	0	59.9	12.1	34.4	50.3	50.6	20.4%	513.1
			(1.6)	(0.9)	(1.8)	(0.3)	(0.3)	(1.6)	(40.7)
2	20	0	46.4	10.1	51.2	50.2	43.3	21.8%	418.9
			(5.3)	(2.6)	(5.5)	(1.0)	(0.7)	(5.7)	(112.5)
3	0	20	59.1	17.4	35.7	58.7	50.8	29.6%	749.7
			(1.6)	(0.8)	(1.5)	(0.3)	(0.3)	(1.4)	(28.2)
4	20	20	48.3	16.4	48.9	57.5	44.5	34.0%	677.0
			(0.7)	(1.4)	(0.9)	(0.4)	(0.5)	(2.9)	(56.4)

[a] Mean and standard error (n=10)

[b] Sum of succeeded ideas' difficulty

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