

ASKING THE RIGHT QUESTION:

HOW ROBOT ELICITATION STRATEGIES SHAPE ENGAGEMENT AND SUBSTANTIVE CONTRIBUTION IN CREATIVE GROUP IDEATION

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01 INTRODUCTION

Social robots are increasingly viable as facilitators in group ideation, where they can influence not only human-robot interaction, but also how participants interact with each other.^{1 2} Prior work shows that robots can facilitate creative collaboration, but their effects are context-dependent rather than automatically beneficial.^{3 4} Existing robot-facilitated brainstorming studies have often examined whether a robot facilitator improves group performance, or how single robot behaviors affect collaboration,^{2 4} but left a gap open on how robot facilitation could support engagement and substantive contribution throughout creative ideation processes.

ENGAGEMENT - the process by which two or more participants establish, maintain and end their perceived connection during interactions they jointly undertake.⁵

CONTRIBUTION SUBSTANTIVENESS - the extent to which participant talk adds task-relevant idea content that goes beyond what has already been stated, by adding, developing, questioning, defending, challenging, or building on task-relevant ideas.⁶

Creative Ideation Phases⁷



02 RESEARCH QUESTION

"How do robot elicitation strategies shape engagement and participant contribution substantiveness in creative group ideation processes?"

SQ1: At each phase of the creative ideation process, how do elicitation strategies shape participant engagement?

SQ2: At each phase of the creative ideation process, how do elicitation strategies shape participant contribution substantiveness?

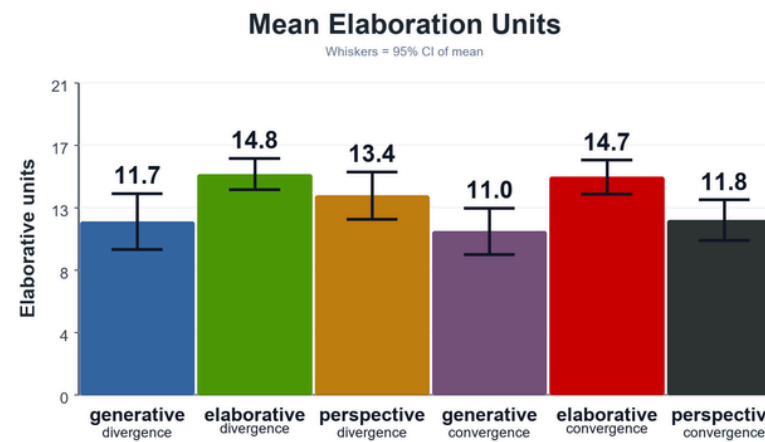
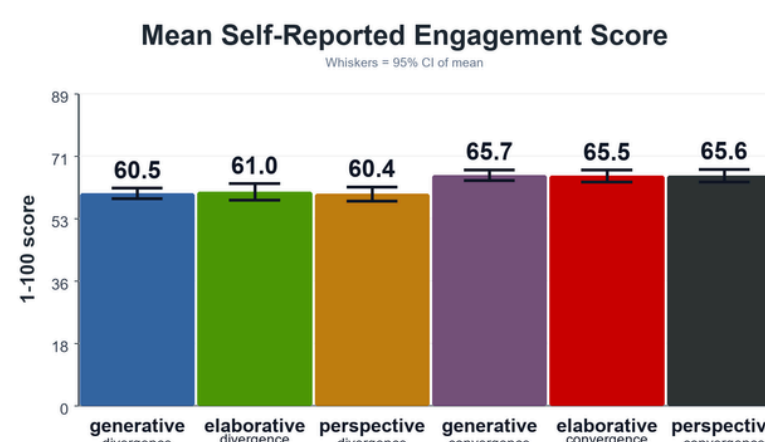
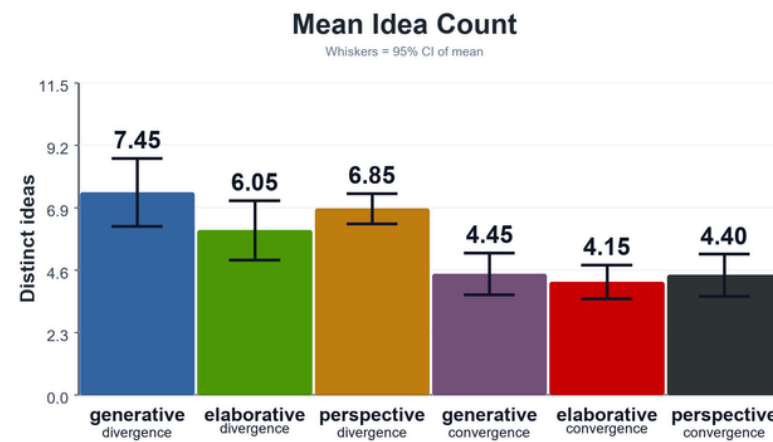
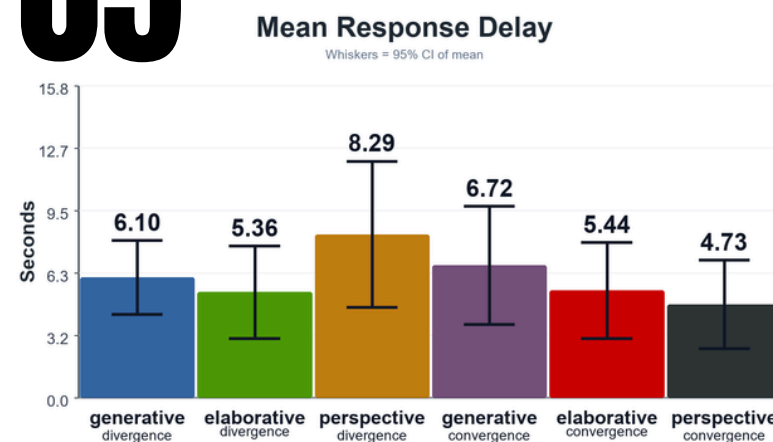
03 ELICITATION STRATEGIES

Perspective-shifting
Encourages to reconsider idea from another user/ stakeholder perspective.⁸
"How would this work for first-year students?"

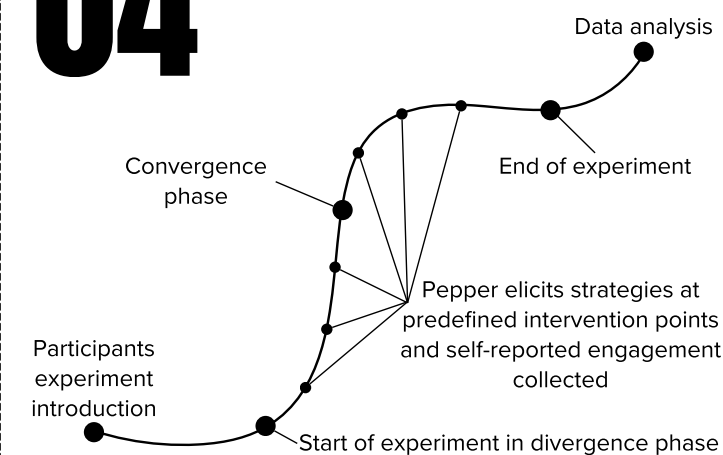
Generative
Encourages to produce additional ideas or alternatives.⁹
"What else could work?"

Elaborative
Encourages to develop an existing idea in more detail.¹⁰
"How would that work in practice?"

05 RESULTS



04 USER EXPERIMENT



MEASUREMENT

SQ1
Self-Reported Engagement⁵
Average Speaking Time¹¹
Vocal Activation Score¹¹
Response Delay¹²
Connection Cue Rate¹³

SQ2
Idea Count¹⁴
Elaboration Units¹⁴
Consecutive Turns on Same Idea¹⁵

$$\text{ConnectionCueRate}_w = \frac{\text{backchannels}_w + \text{laughter}_w + \text{overlaps}_w}{\text{participant speaking minutes}_w}$$
$$\text{VocalActivation}_w = 50 + 50 \cdot \frac{z(\log(1 + \overline{\text{RMS}}_w)) + z(\text{words}/s_w) - z(\text{long pause } s/\text{min}_w)}{3}$$

, where $\overline{\text{RMS}}_w$ = mean audio energy and $z()$ is the unit standardization function

06 CONCLUSIONS

Pepper's effect was not a general robot-facilitator effect, but a prompt-level shaping effect: robots can influence participant interaction² and facilitation benefits depend on behaviour rather than presence alone.³

The main discovery was that Pepper's questions mattered differently across ideation phases. In divergence, generative prompts kept the search space open and supported broader idea production.⁹ In convergence, Pepper became more useful because groups had concrete ideas to compare, refine, and challenge. Elaborative prompts deepened discussion by pushing mechanisms, constraints, and practical details.¹⁰ Perspective-shifting showed the strongest phase dependence: once groups had concrete ideas from divergence, the stakeholder perspective helped them judge which ideas would actually work.¹⁶ Engagement demonstrated its multi-dimensionality as its metrics did not move together.¹¹ Overall, robot facilitation should be designed as phase-sensitive prompt behaviour: broaden discussion in divergence, deepen ideas when needed, and use stakeholder perspectives during evaluation.

¹ Sebo et al. (2020). Robots in groups and teams: A literature review. Proceedings of the ACM on Human-Computer Interaction, 4(CSCW2), Article 176. <https://doi.org/10.1145/3415247>

² Gillet et al. (2024). Interaction-shaping robotics: Robots that influence interactions between other agents. ACM Transactions on Human-Robot Interaction, 13(1), 12:1–12:23. <https://doi.org/10.1145/3643803>

³ Geerts et al. (2021). Brainstorming with a social robot facilitator: Better than human facilitation due to reduced evaluation apprehension? Frontiers in Robotics and AI, 8, 657291. <https://doi.org/10.3389/frobt.2021.657291>

⁴ de Rooij et al. (2024). Co-creating with a robot facilitator: Robot expressions cause mood contagion enhancing collaboration, satisfaction, and performance. International Journal of Social Robotics, 16, 2133–2152. <https://doi.org/10.1007/s12369-024-01177-3>

⁵ Sidner et al. (2005). Explorations in engagement for humans and robots. Artificial Intelligence, 166(1–2), 140–164. <https://doi.org/10.1016/j.artint.2005.03.005>

⁶ Chi (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. Topics in Cognitive Science, 1(1), 73–105. <https://doi.org/10.1111/j.1756-8765.2008.01005.x>

⁷ Isaksen et al. (2011). Creative approaches to problem solving: A framework for innovation and change. SAGE Publications.

⁸ Grant and Berry (2011). The necessity of others is the mother of invention: Intrinsic and prosocial motivations, perspective taking, and creativity. Academy of Management Journal, 54(1), 73–96. <https://doi.org/10.5465/amj.2011.59215085>

⁹ Nijstad and Stroebe (2006). How the group affects the mind: A cognitive model of idea generation in groups. Personality and Social Psychology Review, 10(3), 186–213. https://doi.org/10.1207/s15327957pspr1003_1

¹⁰ Chin (2007). Teacher questioning in science classrooms: Approaches that stimulate productive thinking. Journal of Research in Science Teaching, 44(6), 815–843. <https://doi.org/10.1002/tea.20171>

¹¹ Sorrentino et al. (2024). From the definition to the automatic assessment of engagement in human-robot interaction: A systematic review. International Journal of Social Robotics, 16, 1641–1663. <https://doi.org/10.1007/s12369-024-01146-w>

¹² Templeton et al. (2022). Fast response times signal social connection in conversation. Proceedings of the National Academy of Sciences, 119(4), Article e2116915119. <https://doi.org/10.1073/pnas.2116915119>

¹³ Vinciarelli et al. (2015). When the words are not everything: The use of laughter, fillers, back-channel, silence, and overlapping speech in phone calls. Frontiers in ICT, 2, Article 4. <https://doi.org/10.3389/fict.2015.00004>

¹⁴ Kim (2006). Can we trust creativity tests? A review of the Torrance Tests of Creative Thinking (TTCT). Creativity Research Journal, 18(1), 3–14. https://doi.org/10.1207/s15326934crj1801_2

¹⁵ Barron (2003). When smart groups fail. The Journal of the Learning Sciences, 12(3), 307–359. https://doi.org/10.1207/s15327809jls1203_1

¹⁶ Hoever et al. (2012). Fostering team creativity: Perspective taking as key to unlocking diversity's potential. Journal of Applied Psychology, 97(5), 982–996. <https://doi.org/10.1037/a0029159>