**How does a peer-matching interface for collaborative brainstorming influence cognitive flexibility, sustained attention, and the quality of idea development**

Abstract

The study aims at investigating the effects of a peer-matching interface to collaborate in brainstorming on cognitive flexibility, maintenance of attention, and the quality of the ideas generation process in general. We developed an original, adaptive algorithm that pairs the participants with complementary cognitive and interaction profiles in order to maximize creative synergy in the remote collaboration setting. The research applied to 120 subjects and incorporated quantitative measures of cognitive performance with qualitative measures of ideation output. Findings demonstrate that the peer-matching interface produced a significant increase in cognitive flexibility, enhanced sustained attention and yielded a greater number of original and well-developed ideas relative to the use of traditional brainstorming formats. The academic networking sites like LinkedIn and ResearchGate played a significant role in the recruitment of participants and the interaction after the sessions but presented issues linked to the diversity of users, engagement, and collaboration in real-time. I was the lead researcher and developed the peer-matching theoretical framework, designed the experiment, coordinated participants via academic platforms, and was the primary Age analysing and interpreting the data. Among the findings is a great insight in designing smart collaboration tools in both educational and professional innovation settings.

**Introduction**

Inхоdiernal knowledge economies are evolving at a very high rate, therefore, the capacity to come up with original idea upon collaboration is now a critical cognitive and professional resource. Nevertheless, the classic forms of collaborative brainstorming usually have the weaknesses of groupthink, ambitious participation, and disparate cognitive styles among workforce members, thus being counterproductive in creativity and long-term involvement. This work is dealing with a vital problem, which consists of finding a solution to the creation of intelligent systems that can promote a more effective collaboration by providing cognitive flexibility and maintaining attention and improving the quality of idea elaboration.

Amider the wider scope of human-computer interaction, cognitive science and educational technology, the idea of extending human inventiveness with the help of digital tools becomes increasingly popular. Although there is past research on the advantages of using structured brainstorming methods or AI-based creativity aids, there is limited research on how dynamic peer-matching interfaces can optimise human collaboration in real-time depending on cognitive diversity. We do our work in the complexity of collaborative cognition, computational creativity and digital learning environments, and build up on both theoretical insight and practical tool design.

The study presents a new peer-matching interface, which matches individuals with complementary cognitive and behavioral profiles, and the matching is aimed at making the idea exchange more productive and more flexible. Our study, through the systematic analysis of its impact on cognitive flexibility, level of attention and quality and novelty of ideas generated, closes a serious gap in the design of intelligent collaborative systems. Moreover, we determine the way academic networking websites, such as LinkedIn and ResearchGate, which are popular in the professional and academic world, can simultaneously promote and constrain participant involvement in these settings.

The international impact of the work is explained by its possible use in remote education, interdisciplinary studies, innovation-based sector, and virtual team management. As the world becomes more digital and distributed, technologies to support creative collaboration in a smart way are key to scale human potential.

**Review of Literature / Background**

Group brainstorming has been extensively researched as a creativity technique since the early work of Osborn (1953), which made the technique popular at least in the academic and organizational contexts. Nevertheless, long-term follow-up investigations have also revealed some unresolved drawbacks, which include fixation of ideas, production blocking as well as cognitive overload (Diehl & Stroebe, 1987; Paulus & Nijstad, 2003). The said problems are pronounced especially within group settings that are less structured or less diverse in the way of thinking.

In order to deal with these issues, the recent research has examined the digital intervention to assist with group ideation. In one example, real-time prompting (Kohn, Paulus, & Choi, 2011) tools, visual mapping (Goldschmidt, 2016), and asynchronous input (Dennis & Valacich, 1993) tools have demonstrated potential to enhance idea fluency and elaboration. Besides, AI-enhanced creativity and human-computer interaction have given rise to intelligent co-creation platforms (Frich et al., 2019), even though the majority of them remain individual-augmenting (as opposed to peer-to-peer optimizing).

A smaller, but accumulating literature has focused on peer-matching and team formation in educational, and professional contexts. To give some examples, Hong and Page (2004) pointed out the usefulness of cognitive diversity in problem-solving groups, whereas research by Lykourentzou et al. (2016) showed that algorithmic team formation could boost performance in crowdsourced tasks. These studies however tend to use fixed demographic or skill based requirements instead of using dynamic, behaviour based cognitive profiling; a shortcoming that our study seeks to address.

In contrast to the earlier models, our peer-matching interface uses real-time information and interaction signals to dynamically match the participants in a manner that encourages cognitive flexibility, maintains attention over time and originality of ideas. Also, we explore the niche of external academic networking resources, such as LinkedIn and ResearchGate, not as the passive networking resources, but as the active ecosystems that stimulate or hinder engagement and idea generation. This stratified position places our effort as a step forward in the modeling of digital spaces of creative association.

Our study can be deemed as both a methodological and conceptual pivot towards intelligent human matching to perform collective ideation, as it combines adaptive algorithms with the cognitive science principles to provide a scalable model of remote learning, innovation studios, and international research consortia.

**Methodology**

This paper reported a mixed-methods experimental research that aimed to assess the effect of a peer-matching interface on cognitive flexibility, sustained attention, and quality of ideas in collaborative brainstorming activities. The study method was deliberately designed to be reproducible and transparent, having a clearly determined selection criteria of participants, standardized cognitive tests, and a new digital collaboration platform.

Subjects and Recruitment

The sample size amounted to 120 individuals (20 45 years old) who were reached through academic networks (LinkedIn, ResearchGate), which implies the variability in both disciplinary backgrounds and professional experience. A baseline cognitive flexibility task (with modified Wisconsin Card Sorting Task) and a brief attention control measure (SART -Sustained Attention to Response Task) were used to generate cognitive profiles through initial screening.

Experimental Design

The participants were randomly assigned to two conditions (1) Adaptive Peer-Matching Interface (experimental) and (2) Random Pairing Interface (control). Every meeting consisted of two 45 min brainstorming activities on open-ended innovation challenges (e.g., solutions to climate problems, reform in education). Each of the sessions took place in a specially designed virtual collaboration environment (controlled prompts, time limit, logging of the interaction).

Method Design Innovation

The adaptive peer-matching algorithm is the key innovation: it relied on participant profiles, consisting of cognitive measures, interaction log and engagement pattern to dynamically match individuals who were likely to achieve diverse thinking with one another. This methodology contrasts with the team formation based on status quo or demographics as applied in previous research. The matching was readjusted following the initial task in accordance with new behavioral evidence (e.g. response timing, idea elaboration rates).

Measure and Data Collection

Quantitative outcomes comprised cognitive flexibility scores before and after the job, attention results, and usage logs of the system. Recorded brainstorm outputs were qualitatively analysed and individually scored by three expert evaluators on measures of originality, elaboration and feasibility (on a 5-point scale, based on Creative Product Semantic Scale framework).

Data Analysis

ANOVA and regression models of statistical analysis were used to test the significant difference among groups in all outcome variables. The evaluation consistency was high with inter-rater reliability of qualitative scoring greater than 0.85 (Cohen kappa).

**Results**

The findings are both quantitative and qualitative in giving indications that the peer-matching interface had a substantial positive effect on cognitive flexibility, maintained attention, and the overall quality of ideas produced in the course of the collaborative brainstorming.

### **1. Cognitive Flexibility (Quantitative)**

Experimental group (adaptive peer-matching) participants demonstrated significant change in post-task cognitive flexibility measures in comparison with the control group.

Table 1 : Quantitative Cognitive Flexibility

● **Mean Improvement:**

○ Experimental: +17.4 points

○ Control: +6.3 points

○ *F*(1,118) = 14.27, *p* < 0.001

### **2. Sustained Attention (Quantitative)**

SART results indicated higher accuracy and fewer lapses in the experimental group during brainstorming sessions.

Table 2 : Quantitative assessment of Sustained Attention

● **Accuracy Rate:**

○ Experimental: 92.1%

○ Control: 83.7%

○ *t*(118) = 3.64, *p* < 0.01

### **3. Idea Quality (Qualitative & Quantitative)**

Ideas produced by the experimental group were rated significantly higher in terms of originality, elaboration, and feasibility.

Table 3 Qualitative & Quantitative Idea Quality

|  |  |  |  |
| --- | --- | --- | --- |
| Metric | Experimental | Control | p-value |
| Originality | 4.3 / 5 | 3.5 / 5 | < 0.001 |
| Elaboration | 4.0 / 5 | 3.2 / 5 | 0.002 |
| Feasibility | 3.9 / 5 | 3.4 / 5 | 0.012 |

### **4. Engagement Analysis (Behavioral Logging)**

Engagement logs revealed that matched peers in the experimental group exchanged 35% more messages and engaged in 28% longer idea elaboration threads.

Table 4 Engagement Analysis for Behavioral Logging

● **Mean Messages per Session:**

○ Experimental: 47.6

○ Control: 35.1

### **Unexpected Finding**

Surprisingly, the studies have shown that the recruitment via LinkedIn resulted in a highly engaged group compared to ResearchGate, where the rate of idea contribution was 22 percent higher. This implies that professional networks could encourage greater responsiveness to collaboration than academic platforms.

When combined with those above, these results verify the usefulness of an adaptive peer-matching program in enhancing creative performance, attention, and cognitive flexibility. They additionally emphasize the possible role and weaknesses of the academic networking sites in maintaining significant interaction throughout the ideation activities.

**Discussion**

Overall, the findings of the present research make clear that an adaptive peer-matching interface can greatly promote cognitive flexibility, maintains attention and the quality of idea elaboration in collaborative brainstorming contexts. The findings solve long-term shortcomings in the study of group ideation, especially those linked to cognitive incongruity, checkout and non-productive group processes (Diehl & Stroebe, 1987; Paulus & Nijstad, 2003).

Our dynamic peer-matching framework is an improvement over the previous systems, which either assist individual creativities (Frich et al., 2019) or are based on unchanging groupings (Lykourentzou et al., 2016). Our ability to match participants in real-time using cognitive and behavioral data allowed us to not only enhance the level of interaction but also creative output, which, in the literature of brainstorming, is seldom attained in conjunction with one another. Furthermore, we propose to combine aspects of cognitive science, interaction design, and human-AI teaming principles in a new manner that transcends the Facilitation models that have thus far been rather fixed in their facilitation.

One of the most interesting results was that of improved sustained attention of the matched peers. That indicates a possibility of well-aligned partnerships being less cognitively taxing and more mutually attentive, which is yet another indicator not only of cognitive but also of emotional and motivational alignment as a design concern. Our process also seems to tacitly foster what might be called constructive friction between divergent but complementary styles of thinking, challenging and sharpening one another, coming up with more novel and viable ideas.

The implications of this work are also enhanced by the role of academic networking sites, which include LinkedIn and ResearchGate. Although they were effective in recruitment of participants and post-session informal communication, the data demonstrate that the level of engagement on the platforms was different, which means that social context and professional culture do affect digital collaboration. Such an observation may be used to shape the design of platform-specific engagement strategies on future collaborative tools.

Social and Manufacturing Effect

The social significance of this study is enormous. In distance learning this technique can be used to maximum advantage in collaborative student efforts by matching learners into cognitively compatible pairs which could enhance retention as well as learning. Embedded in virtual work platforms, intelligent peer-matching tools have the potential to release more creativity, decrease burnout and enhance ideation throughput in industry, especially within R&D and innovation teams.

**Future Directions**

The next steps of research will be (1) enlarging the dataset with cross-cultural participants to check the generalizability, (2) improving the matching algorithm with machine learning methods, and (3) considering the integration with third-party apps, like Slack or Microsoft Teams. There is also a need to conduct longitudinal studies to gauge the long-term effect of such interfaces over an extended period of time in the real world team settings.

Taken together, the present research design has empirically delivered convincing evidence to support the argument that cognitive-conscious, adaptive peer matching has a great potential of enhancing the creative collaboration process. It will bring a scalable, pragmatic model of designing intelligent digital collaboration systems in the fields of education, research, and professional practice.

**Conclusion**

The current research proposes and confirms the effectiveness of a new peer-matching interface aimed at facilitating cooperative brainstorming sessions to promote greater cognitive flexibility, maintaining attention, and idea quality output. Using dynamic cognitive profiling and adaptive pairing algorithms, we were able to show that intelligently paired participants generated more original, elaborated and viable ideas than the randomly paired participants. With the methodology we have not only contributed to the theoretical knowledge about collaborative cognition but we also provide a practical means of achieving high impact digital collaboration.

The study is unique in the way it brings together cognitive science, human computer interaction, and real time behavioural data to address age old problems with group creativity. This way, it addresses a much needed gap in educational and professional innovation settings where the dynamics of a team usually makes the difference in the success of an ideation process. Furthermore, through the evaluation of the position of academic networking sites such as LinkedIn and ResearchGate, our research offering will give a more complex understanding of the collaborative opportunities and constraints that current digital ecosystems can facilitate.

Current efforts are aimed towards developing the matching system further to incorporate machine learning to each pairing more sensible and scalable. We are also considering integration into real world collaborative platform and virtual learning environments to evaluate the longitudinal effects on innovation and learning outcomes.

Overall, the study represents a valuable methodological and conceptual contribution to the area of digital collaboration and sets exciting avenues of applied innovation as well as cognitive-enhancement technologies.

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