Digitally Nudging Team Processes to Enhance Collective Intelligence

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1. INTRODUCTION

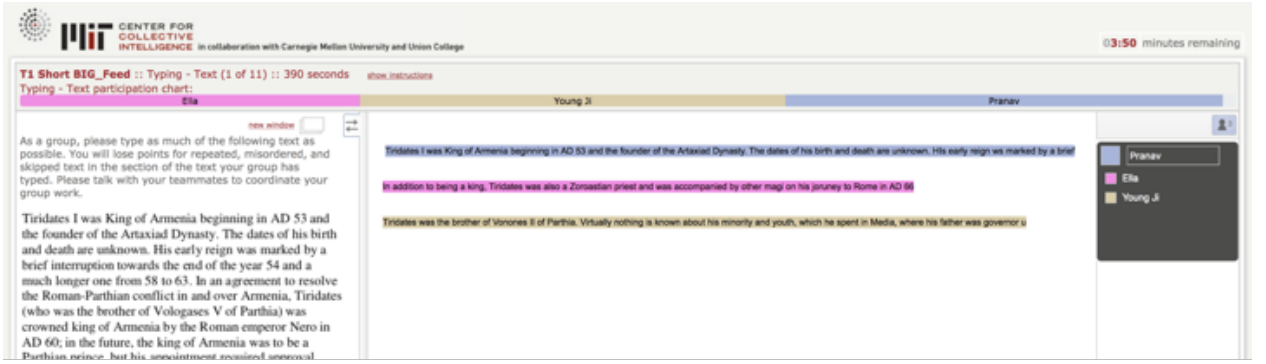
A wide range of digital technologies ranging from passive tools to automated assistants, to intelligent algorithms are increasingly becoming a part of organizational life. They help accomplish work by augmenting as well as transforming individual and collective cognitive processes. Consciously or unconsciously, the presence of such digital technologies influences the decision-making context or what behavioral economists refer to as the 'choice environment' [Thaler and Sunstein 2009]. Digital nudging or choice architecture is the deliberate use of user-interface design elements to guide people's behavior in digital choice environments [Weinmann et al. 2016]. So far, nudging has been shown to guide individual behavior (e.g. increase tipping in payments apps or consenting to organ donation). We propose extending the principles of choice architecture or nudging to teams. In other words, we ask: Can the inclusion of simple, targeted digital technologies be used to guide not just individual cognition but also interactive team processes with the ultimate aim of enhancing the team's ability to perform collectively? And, particularly as nudges become enhanced with artificial intelligence such that their form and timing are responsive and adaptive to team process, can we see artificial intelligence enhance team collective intelligence?

1.1 Nudging Collective Intelligence

The work of Woolley et al. [2010] demonstrated the existence team collective intelligence (CI) - a generalized ability of a team to perform well across a wide variety of tasks. While a series of studies has explored the generalizability and predictive validity of CI [Engel et al. 2014; Engel et al. 2015; Kim et al. 2017], one interesting question has been largely unexplored. Is collective intelligence mutable? Or, said differently, can we enhance the collective intelligence of teams?

A natural focus for enhancing CI would be the alteration of team process. Hackman and Wageman [2005] identified three categories of processes that enhance the ability of a team to perform: (a) the level of effort team members collectively expend carrying out task work; (b) the appropriate choice of performance strategies the team uses in its work; and (c) the amount of knowledge and skill members bring to bear on the task. Subsequent research has sought ways to reliably elicit these processes in teams, in the form of team training, team coaching, launch briefings, and interventions. And while many of these strategies have a positive effect on team performance, their implementation comes at significant expense, and at times without large or consistent results.

Perhaps, digital nudging can be a cost-effective and practical way for improving these team performance processes. Particularly algorithmically-driven nudges, which stand ready to intervene at specific times and in response to specific behaviors, could yield greater benefits than reliance on highly erratic human coaches. Thus, the goal of this study is to design and test three digital nudges focused on the three team performance processes (level of team effort, choice of team strategy, and appropriate use



(a) Automated Effort Feedback Nudge

(b) ToDo Tool Nudge

Fig. 1: Sample screen from the Platform for Online Group Studies (POGS); On the top of the interface the (a) automated-effort-feedback; (b) todo-tool is featured.

of member skills) to examine their impact on team collective intelligence. In addition, we will want to examine human responses to being managed by technology, as human reaction will play a large role in the adoption and acceptance of such tools (see Glikson and Woolley [forthcoming]).

2. METHODS

Our sample includes 416 Amazon Mechanical Turk workers randomly assigned to 136 three- or four-member teams. These teams were randomly assigned to one of the four conditions (control, automated-effort-feedback, todo-tool, or chatbot-facilitator intervention, described further below). The sample was 37.5% female and the average age was 35.3 years old ($SD = 9.9$). All teams completed the Test of Collective Intelligence (TCI), an online test battery of eight group tasks designed to measure team collective intelligence [Engel et al. 2014; Kim et al. 2017]. The TCI was administered via the Platform for Online Group Studies (POGS), a browser-based platform for running group studies that involve synchronous collaboration and interaction. As shown in Figure 1, the interface contains the task instructions on the left and a collaborative workspace in the center of the screen where all members can see the input of other members updated synchronously. On the right panel, team members can communicate with each other using text-based chat.

2.1 Digital Nudge Interventions

To compare the effects of digitally nudging team processes on CI, we developed three features embedded in POGS: (a) an automated-effort-feedback tool, which is a real-time effort indicator that quantifies the amount of contribution made by each team member (Figure 1a). This nudge is designed to evoke the social norm of equal contribution and expected to influence low contributing members to increase their individual effort thereby increasing the overall level of effort of the team; (b) a todo-tool, which guides the team to explicitly think about task allocation, a central aspect of team performance strategy, by stimulating consideration of who should do what; and, and, (c) a temporally-triggered chatbot, designed to stimulate members to think about the application of member knowledge and skill. This third tool is grounded in research on team pacing and transitions [Gersick 1989; Okhuysen and Waller 2002]. The chatbot sent two messages in each of the eight tasks, one at the very beginning of the task and another at the midpoint. The beginning message was designed to encourage teams to identify the task-relevant expertise within the team (e.g., "This is a good time to discuss who has experience with this type of task. How should you work together? Who should do what?") allowing for appropriate work assignment. The midpoint message was designed to check in with teams and invite them to reevaluate their status moving forward (e.g., "How is your progress?"). Participants in this conditions were told at the beginning of the experiment that there would be a chatbot facilitator helping teams work together more effectively. And finally, the control condition did not include any of these interventions.

2.2 Measures

The three performance processes were measured using team activity data captured in POGS. Level of effort was operationalized by aggregating the number of keystrokes made by the team across the eight tasks. Use of appropriate task performance strategy was operationalized by calculating the average task coverage (i.e. percentage of tasks completed by the team). And, appropriate use of member skills was operationalized by a correlational measure that captures the task-wise congruence of member skill with their effort on each task. Finally, CI was measured using the Test of Collective Intelligence (TCI). The TCI consists of a wide range of group tasks such as generating, problem solving, executing, and memorizing (for more details, see Kim et al. [2017]). A teams CI score was computed by taking an average of standardized scores across eight such tasks. We controlled for team size, social perceptiveness and extent of conversational turn-taking as they have been shown in prior studies to predict CI [Woolley et al. 2010].

3. RESULTS

To test our hypotheses that our three digital nudges will enhance CI via their effects on the three team performance processes (level of team effort, appropriate choice of team strategy, and appropriate use of member skills), we ran the Hayes PROCESS model for multiple mediation analysis with multicategory independent variables. Results show that the improvements in three performance processes indeed enhance CI ($R^2 = .207, p < 0.05$). Moreover, the processes also significantly mediate the digital nudges and CI relationship.

However, in looking at the effects of each process nudge individually, alongside user reactions, we see that some had the intended effect on their respective process, while others did not. First, the presence of the chatbot facilitator increased the chances of that the most skill-suited members for a given task exerted the maximum effort on that task ($b = 0.095, p < 0.5$). But, the users had mixed reactions in response to being 'facilitated' by a bot. For example, one participant commented "They were helpful at the beginning to point out that we should strategize our skills, but after that they were useless and distracting" and "He didn't answer questions that other members had." Perhaps, there is a baseline

expectation for the level of intelligence expected of a virtual assistant and, even though successful, our minimal chatbot didn't meet the user expectations. Next, the todo-tool did not have a significant effect on improving teams task performance strategy ($b = -2.45, p > 0.05$). The manual nature of it was too work intensive for participants, as one explained: "I used it once to test it out, but it didn't really seem that useful to me time spent creating a ToDo could have been spent trying to do the actual task." Finally, and to our surprise, the presence of automated-effort-feedback had a negative effect on the total level of effort ($b = -9.06, p < 0.5$). It seems that, rather than encouraging greater effort, the feedback influenced the low contributors to prematurely abandon their efforts instead of trying to equalize them, allowing the best member to do the majority of the work. This indicates the need for choice architects and IS developers to deeply understand and test the social and psychological effects of their nudge design decisions.

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