Collective Intelligence and its Relationship to Collective Individual Intelligence in Virtual Teams

Jordan B. Barlow

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Jordan B. Barlow
Opus College of Business
University of St. Thomas (Minnesota)

Research-in-Progress

ABSTRACT

Collective intelligence is a measure of a small group's ability to perform well not only on a single task, but consistently well across multiple tasks. Previous literature studying this construct has mixed findings for both virtual and face-to-face groups. Given the prevalence of remote work and the increase of virtual teamwork, we believe it is important to more fully understand what may contribute to the collective intelligence of virtual teams. In this work-in-progress study, we collect data from teams working virtually on a variety of tasks and measure how the aggregated individual intelligence of group members contributes to the performance of groups. While previous studies have not reported whether such a correlation exists, focusing instead on other contributors to collective intelligence such as group level interactions, our preliminary findings indicate that virtual collective intelligence is influenced by the abilities of individual group members on average.

Keywords

Collective intelligence, individual intelligence, virtual teams, collaboration.

INTRODUCTION

An important stream of research in information systems involves the understanding of how groups perform when using technology and computer-mediated communication. Since the COVID-19 pandemic, much work has moved to an online environment; thus, understanding what leads to success for groups working through technology is more important than ever.

Among many constructs measured in the literature on group performance, one that has recently gained traction among researchers is *collective intelligence*. In their seminal work, Woolley et al. (2010) defined collective intelligence as the ability of a group to perform consistently well across multiple types of tasks, in much the same way as individual intelligence measures cognitive ability by measuring performance on a variety of tasks (Woolley et al. 2010). The concept of collective intelligence and its conceptual underpinnings for both virtual and face-to-face teams has been debated in published literature for over a decade. A recent meta-analysis showed that collective intelligence as a construct seems to be most relevant for groups that work in well-structured (not ill-structured) tasks (Graf-Drasch et al., 2022).

Despite the extensive research on collective intelligence over the past decade, the relationship between individual and collective intelligence remains unclear. Individual intelligence was significantly correlated with collective intelligence in one of Woolley et al.'s (2010) landmark studies, but not in the other. Subsequent studies measuring a collective intelligence factor (Engel et al. 2014; Engel et al. 2015; Aggarwal et al., 2015; Kim, Aggarwal, & Woolley, 2016; Kim, Engel, et al., 2016; Meslec et al., 2016; Chikersal et al., 2017) typically have not reported correlations with aggregated individual intelligence. Thus, more research is needed to better understand this relationship. Do virtual groups perform better when made up of more intelligent individuals?

THEORETICAL BACKGROUND AND HYPOTHESES

According to Coordination Theory, group tasks are made up of two types of work: production and coordination (Malone & Crowston 1990, 1994). Production is the work that individuals in the group complete and is likely influenced by individual intelligence. Coordination, the managing of interdependencies among resources and group members, is not as well predicted by individual intelligence. Research on individual intelligence in groups has long argued that the (mixed) effect of group member intelligence on group performance in a single task is limited because the coordination required in group tasks makes them different from individual tasks (O'Brien & Owens 1969). While the effects of individual intelligence have been studied on group performance on a single task many times (especially in face-to-face groups) (Devine & Phillips, 2001), there is still little understanding of how individual intelligence contributes to the collective intelligence of a group, or its ability to perform well on a *variety* of tasks, particularly in online settings where coordination tends to be more difficult.

It is possible that in the Woolley et al. (2010) studies, individual intelligence was not related to group performance because of the need to perform coordination among group members. Such coordination was likely facilitated by the social sensitivity of members working face-to-face with visual cues; Woolley et al. (2010) reported such social sensitivity as a significant predictor of a group's collective intelligence.

Our research consists of two studies designed to further our understanding of the relationship between the individual intelligence (IQ) of group members and the collective intelligence of a group (i.e., across-task performance), particularly for online groups. The first study examines various aggregation methods of IQ to the team level, and their effects on collective intelligence measured as across-task performance on both high- and low-coordination tasks. The second study examines aggregations of IQ to the team level and their effects on collective intelligence measured through MIT's collective intelligence online battery of tasks, a set of low-coordination group tasks.

For Study 1, we theorize that when online groups follow a process that highly structures their coordination procedures, the average intelligence of team members should lead to a collectively intelligent team. Minimum intelligence should also matter in these situations because the group must rely on all members to perform most group tasks, especially those where all individuals must contribute in order for the group to be successful. On the other hand, maximum intelligence is often related to group performance only on certain types of tasks that don't require thorough work from each member of the group (Day et al. 2004). Low-coordination tasks such as brainstorming should not be highly affected by maximum intelligence because performance is dependent on having more than one group member do well. Even though we believe the effect of maximum intelligence on performance will be stronger in certain tasks, we posit that, overall, maximum intelligence still will not be highly related to collective intelligence, because a team that performs well across many types of tasks will need more than simply relying on its most intelligent member.

Hypothesis 1: (a) Average and (b) minimum individual intelligence will be positively related to collective intelligence (as measured using a set of three full low- and high-coordination tasks) in structured online teams, but (c) maximum individual intelligence will not.

The second study will examine the relationship between individual intelligence and collective intelligence as measured using MIT's collective intelligence online battery of tasks (Engel et al., 2014; Engel et al., 2015; Chikersal et al., 2017). This online battery of tasks has been used and validated in several studies and has also been shown to predict performance on larger group-based tasks (Kim, Engel, et al., 2016). The tasks used in this group activity are short and comparable in nature to the types of problems used in individual intelligence tests, involving little coordination in comparison to other types of group tasks. Specifically, when comparing the tasks of the MIT battery to the tasks used in Study 1, the tasks have fewer convergence and conveyance requirements. That is, with the type of tasks used in this measurement, a group should perform well if one or two group members perform well (i.e., if the group has a high maximum IQ). In contrast to H1, performance in this case should not be predicted by minimum individual IQ because with these types of tasks, it is not required that all group members perform well in order for the group to perform well as a whole. Thus, while average individual intelligence should matter for both sets of tasks, the effect of minimum and maximum IQ will depend on the set of tasks chosen for groups.

Hypothesis 2: (a) Average and (b) maximum individual intelligence will be positively related to collective intelligence (as measured using the MIT online collective intelligence battery of tasks), but (c) minimum individual intelligence will not.

Finally, the effect of average individual intelligence on a group's collective intelligence may be contingent on several factors. Individual intelligence helps groups perform well on the production portion of group tasks, but we theorize that coordination can interfere with the effect of IQ on overall group performance. Groups with a healthy transactive memory system should be highly equipped to effectively coordinate their work (Aggerwal et al., 2015). Therefore:

Hypothesis 3: The relationship between average individual intelligence and collective intelligence will be stronger in teams with a higher level of transactive memory systems.

METHODS AND RESULTS

This research consists of two studies. Study 1 (testing H1) has been completed, while Study 2 (testing H2 and H3) is a work-in-progress.

In Study 1, 64 groups of 3-5 members completed one low-coordination task (brainstorming) and two high-coordination tasks (college admissions task and candy profitability task) using a set of highly structured Google Sheets and communicating using only Google Chat. The tasks used for this study were taken from Barlow and Dennis (2016), and thus have been validated in previous studies. In contrast to Barlow and Dennis (2016), teams were provided with a highly structured shared virtual workspace, allowing the tasks to be more well-structured in line with the findings of Graf-Drasch et al. (2022). Collective intelligence was measured using a factor analysis of task scores, following the procedures of Woolley et al. (2010). Specifically, performance scores on the three tasks were used in a factor analysis. The factor analysis indicated a one-factor solution, and the calculated factor score from this analysis was used to represent collective intelligence (Woolley et al., 2010). All participants completed the Wonderlic intelligence test and a survey measuring additional variables.

A regression analysis was used to measure the effect of various individual and group level characteristics on the groups' collective intelligence. Average individual intelligence was significantly related to collective intelligence (p=0.05), supporting H1a. Minimum individual intelligence was not significantly related to collective intelligence (p=0.129), indicating no empirical support for H1b. Maximum individual intelligence was not significantly related to collective intelligence (p=0.303), lending support to H1c.

	Avg IQ model (*p*)		Max IQ model (*p*)		Min IQ model (*p*)	
(constant)	-2.506	0.718	-1.704	0.817	-0.920	0.895
Member IQ	0.112	0.050	0.039	0.303	0.085	0.129
% Native English	0.074	0.903	0.352	0.565	0.452	0.435
Gender Diversity	-2.373	0.005	-2.556	0.004	-2.127	0.015
Average Age	0.086	0.768	0.110	0.719	0.029	0.923
Motivation	-0.330	0.317	-0.275	0.418	-0.234	0.482
Note: Shaded cells indicate statistically significant (*p*<0.05) relationships.						

Table 1. Regression Model Showing Predictors of Collective Intelligence

For situations where visual cues are not present, we found that individual intelligence was significantly related to collective intelligence for virtual groups who worked with a set of tools that facilitated the coordination aspects of the work. In these conditions, the researchers essentially converted high-coordination tasks into production-focused tasks. The group work involved less complex coordination, and groups could instead focus on the production portion of the task. Because individual intelligence, by definition, predicts performance across tasks, the relationship between individual IQ and group performance was strengthened as the coordination aspects (those unique issues not inherently improved by individual intelligence) were facilitated.

The data for Study 2 has been collected but not yet analyzed. Participants are students in business courses at a large university. Individuals participated in an online meeting, where they were randomly assigned to a group. Group members completed the collective intelligence battery of tasks (Engel et al. 2014; Engel et al. 2015; Chikersal et al. 2017) and communicated using only the collective intelligence software. Participants also completed a survey measuring individual and group traits, including transactive memory system. Individuals also completed the Wonderlic test to measure individual intelligence.

Data from Study 2 will be analyzed in a similar manner as Study 1. A regression analysis will be performed with collective intelligence as the dependent variable. To analyze the results for Hypothesis 2, three separate models (using average, maximum, and minimum IQ aggregation) will be run. To analyze the results for Hypothesis 3, an interaction effect (IQ x TMS) will be used as an independent variable in the regression analysis.

CONCLUSION

This research will further our understanding of the relationship between individual and collective intelligence in online group work. The results will demonstrate whether collective intelligence is generally predicted by individual intelligence in online groups and will also show whether or not the aggregation method (average, minimum, maximum) makes a difference. Finally, the results will shed light on whether the effect of individual IQ on collective intelligence is stronger in teams with strong transactive memory systems.

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