Not as Smart as We Think: A Study of Collective Intelligence in Virtual Groups

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1. INTRODUCTION

Cross-disciplinary research on collective intelligence considers that groups, like individuals, have a certain level of intelligence. For example, the study by Woolley et al. (2010) indicates that groups which perform well on one type of task will perform well on others. In a pair of empirical studies of groups interacting face-to-face, they found evidence of a collective intelligence factor, a measure of consistent group performance across a series of tasks, which was highly predictive of performance on a subsequent, more complex task. This collective intelligence factor differed from the individual intelligence of group members, and was significantly predicted by members' social sensitivity – the ability to understand the emotions of others based on visual facial cues (Baron-Cohen et al. 2001).

Though these results for face-to-face groups are important, groups are increasingly using information and communication technologies (ICT) to enable virtual work (Chudoba et al. 2005; Montoya et al. 2011). One key question is whether the factor measured by Woolley et al. (2010), which is highly correlated with visual processing (something that is not available in many ICT used by groups), transcends media or is instead a measure of a group's capability to interact in one media where visual processing dominates, i.e., face-to-face communication. Is collective intelligence like individual intelligence, an inherent factor that can transcend media, or is collective intelligence constrained by media or task type?

We examined collective intelligence in an ICT environment in which groups used text-based computer-mediated communication (CMC). We considered that if we were to find evidence of collective intelligence in this environment that is correlated to the same factors as in the Woolley et al. (2010) study of face-to-face interaction, then we could be more confident that that this factor is indeed like general intelligence and transcends media. If we did not find evidence of a collective intelligence factor in groups using CMC, then we would question the generalizability of previous findings and suggest that collective intelligence, as a concept, differs depending on context, and that when using CMC, task requirements may trump any inherent group characteristics.

In other words, it may be that the collective intelligence of a group can only be developed under certain circumstances. Some groups may be more "intelligent" (i.e., high performing) than others, but only when the conditions are right. Such an outcome would demonstrate that for CMC, an inherent disconnect exists between task performance and inherent group characteristics, which makes performance more dependent on task type than on any inherent group characteristic. This would lead us to conclude that different types of tasks have different requirements, and thus the processes groups use to perform them are likely more important in this setting than underlying group characteristics.

A study examining such a potential outcome does not depend on perfect replication of the Woolley et al. (2010) studies. In fact, if we were to conduct a perfect replication of their studies, we would not know if the collective intelligence factor we studied was somehow unique to the tasks and subjects used.

2. METHOD AND RESULTS

Following the basic procedures of Woolley et al. (2010), 324 individuals in 86 groups (of 3-5 members each) completed three initial group tasks and one complex group task. The initial tasks were used in a factor analysis in an effort to find a collective intelligence factor, while the complex task was used to have a single measure of group performance separate from the collective intelligence tasks. (More details about specific procedures and tasks can be found in an online supplement, which is stored at http://jordanbarlow.files.wordpress.com/2014/01/supplement_methods_analysis.pdf.)

We used group performance scores on the set of simple tasks to determine whether a collective intelligence factor emerged from the data. The first criterion is that the average correlation between task scores should be positive (Woolley et al. 2010). In our study, correlations between task scores were either not statistically significant or were significantly negative, as shown in Table 1. The average correlation was -0.12, indicating that performance on one task was not correlated with performance on other tasks. Table 1 also shows correlations between performance scores and other measures we collected during this study. Specifically, we collected the same measures examined by Woolley et al. (2010): individual intelligence (collected through the Wonderlic test), social sensitivity (collected through the Reading the Mind in the Eyes test), speaking turn variance, percentage of females, and group performance on a complex task.

Table 1. Correlations between group tasks and traits.

	1	2	3	4	5	6	7	8	9
1. Brainstorming task									
2. Decision task	-0.14								
3. Negotiation task	-0.25*	-0.09							
4. Complex task	0.02	0.01	0.15						
5. Average intelligence	0.51**	-0.06	-0.02	0.07					
6. Max intelligence	0.47**	-0.11	-0.05	-0.08	0.75**				
7. Percent female	-0.25*	-0.11	0.08	-0.18	-0.37**	-0.22*			
8. Avg social sensitivity	0.34**	-0.26*	-0.09	0.04	0.44**	0.42**	0.01		
9. Max social sensitivity	0.26*	-0.23*	-0.07	-0.09	0.22*	0.32**	0.19	0.63**	
10. Speaking variance	-0.19	0.04	-0.06	0.05	-0.15	-0.04	0.00	0.08	0.07

*p<0.05 **p<0.01

The method to identify an intelligence factor, whether individual or collective, consists of a factor analysis of performance scores on a variety of tasks (Deary 2000; Woolley et al. 2010). The intelligence factor in this factor analysis should (a) account for 30-50 percent of the variance, with the next factor accounting for significantly less, (b) have an eigenvalue greater than 1.38, and (c) demonstrate an obvious elbow in the scree plot (Woolley et al. 2010).

None of these criteria were met in our study. In our principal components factor analysis, the first factor accounted for 42 percent of the variance, but the second factor accounted for 36 percent, suggesting two dominant factors, rather than an emerging intelligence factor. The first factor's eigenvalue was 1.26, and no drop-off elbow appeared in the scree plot, which is shown in Figure 1. Taken together, these analyses indicate that a general collective intelligence factor does not emerge when groups use CMC.
We completed three robustness checks and two validity checks to ensure that our results were not dependent on task selection, extraction method, nor random noise from inattentive participants. (More details about all these robustness checks can be found in the online supplement at http://jordanbarlow.files.wordpress.com/2014/01/supplement_methods_analysis.pdf.)

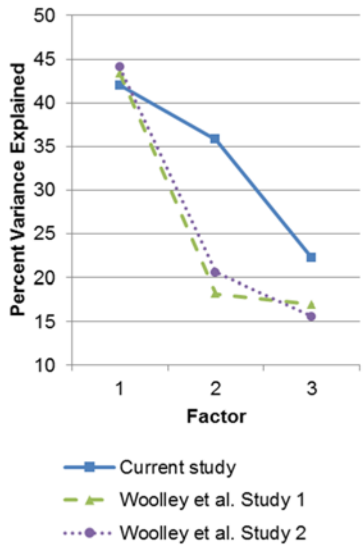

Fig. 1. Scree plots comparing our factor analysis to the Woolley et al. (2010) studies.

3. CONCLUSIONS

The results of this study show that no collective intelligence factor emerged when groups used text-based CMC. An inherent collective intelligence factor similar in nature to individual intelligence should transcend media, indicating that collective intelligence as a concept is different in nature from individual intelligence. We conclude that the factor found by Woolley et al. (2010) is not a general factor of collective intelligence inherent to groups under all conditions, but it is a measure of a group's general ability to work well in face-to-face settings (i.e., face-to-face collective intelligence). Collective intelligence manifests itself differently in virtual settings; that is, groups using CMC do not appear to have an inherent factor that makes some groups more intelligent than others, though perhaps such an ability can be developed over time. Rather, certain characteristics of the tasks more strongly predicted which groups would outperform others.

Regardless of the reasons that face-to-face groups could outperform groups using ICTs (e.g., difficulty with conflict management, difficulty understanding social cues, etc.), the findings indicate that even in sub-optimal conditions, no groups performed consistently better than others. Truly intelligent groups should perform well relative to other groups, across tasks and media, even in conditions where the task and the technology do not fit well together. Therefore, the concept of collective intelligence is more complex than past research suggests, manifesting under some conditions but not others.

We believe there are many open doors for continued research on the conceptualization and measurement of collective intelligence in small groups. These areas include, but are not limited to, the examination of which conditions facilitate collective intelligence, how it might develop over time, how individual and collective intelligence are related under varied conditions, and how social sensitivity affects groups who sometimes work using CMC.

Finally, because no collective intelligence factor emerged in this study, researchers may be able to draw conclusions from and build future studies more deeply examining which of the variables were correlated with specific task scores (see Table 1). That is, because performance on different tasks is not correlated, it is interesting and useful to better understand which factors, such as individual intelligence, relate to performance on specific task types. Future studies should assess why these effects differ depending on the type of task.

REFERENCES

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., and Plumb, I. 2001. "The "Reading the Mind in the Eyes" test revised version: A study with normal adults, and adults with Asperger Syndrome or High-functioning autism," *Journal of Child Psychology and Psychiatry* (42:2), pp. 241-251.

Chudoba, K. M., Wynn, E., Lu, M., and Watson-Manheim, M. B. 2005. "How virtual are we? Measuring virtuality and understanding its impact in a global organization," *Information Systems Journal* (15:4), pp. 279-306.

Deary, I. J. 2000. *Looking Down on Human Intelligence: From Psychometrics to the Brain*, New York, NY: Oxford University Press.

Montoya, M., Massey, A. P., and Lockwood, N. 2011. "3D collaborative virtual environments: Linking collaborative behaviors and team performance," *Decision Sciences* (42:2), pp. 451-476.

Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., and Malone, T. W. 2010. "Evidence for a collective intelligence factor in the performance of human groups," *Science* (330), pp. 686-688.

An expanded version of this paper with additional background, detail, and references, can be accessed at: http://jordanbarlow.files.wordpress.com/2014/03/ci-expanded-paper.pdf