Gaechter, Simon (2017) Occasional errors can benefit coordination. Nature, 545 . pp. 297-298. ISSN 1476-4687

Occasional errors can benefit coordination

[published in slightly revised version as a News & Views article in *Nature* 545, 18 May 2017, 297-298, doi: 10.1038/545297a]

The chances solving a problem that involves coordination between people are increased by introducing robotic players that sometimes make mistakes. This finding has implications for real-world coordination problems. See Letter p.XXX

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Complex human societies exist because people cooperate with each other and coordinate their activities[1]. Cooperation involves collaborating for common benefit, whereas coordination requires people to match their collaborative activities in appropriate ways. This often entails solving small, local coordination problems to achieve global coordination. As an example, consider the production of complex goods, which involves coordinating the division of labour across sites. In this instance, error-prone people must solve many, often intricate, local problems such as work processes, or the logistics of production and supply chains, to achieve global coordination. On page XXX, Shirado and Christakis[2] use network experiments to highlight the ways in which errors can help to improve global coordination.

The authors set up 230 randomly generated networks, each with 20 nodes. They allocated each of 4,000 participants to a node, and asked them to solve a colour-coordination game[3], in which the aim is to make each node one of three colours that differs from the colour of every neighbouring node (Fig. 1).

Players know that they are part of a large network, but see only the colours of their neighbours. They can change their node's colour as often as they like within five minutes. Thus, a player can remove local colour conflicts without solving all colour conflicts glob- ally. People are paid according to how long it takes to solve all colour conflicts in the net- work. This setup is an abstract representation of many real-world coordination problems[3], in which the choices optimal for an individual might not solve a global coordination problem whose resolution is in the collective interest.

In addition to human participants, Shirado and Christakis included three autonomous software agents called bots as players in many of the networks. They programmed the bots to play a locally optimal strategy, but to make a random colour choice a certain amount of the time. The authors tested three levels of randomness — 0% (no noise), 10% (low noise) and 30% (high noise). They placed bots at different positions in different networks: in random, peripheral or central locations. Thus, they tested nine combinations of bot randomness and positioning to examine whether noisy bots help human players.

Of 30 control networks that contained only human players, 67% solved their game within 5 minutes. The remaining groups became stuck in locally unresolvable colour conflicts. Placing low-noise bots in the centre of networks improved success rates: 85% of such networks achieved global coordination within 5 minutes. The presence of these bots also increased the speed with which the problem was solved. Interestingly, the low-noise bots helped to resolve colour conflicts not only by deviating from the locally optimal action, but also because their behaviour nudged human players to occasionally deviate, too. The no-noise and high-noise bots were not that helpful, because they created less-than-ideal levels of deviation (not enough or too much, respectively). Bots placed in the centre of the network had more influence than peripheral bots because they had more links to human neighbours.

Shirado and Christakis suggest that noisy bots could be used as ‘simple artificial intelligence’ tools to help human decision-makers solve real-world coordination problems. But they could also serve as experimental tools, acting as models for human players who are, for whatever reason, occasionally willing to try something new or to disrupt the situation even if they do not fully understand what they are doing. Indeed, there was evidence that such individuals were present in the authors’ control experiments — some conflicts were resolved because players temporarily deviated from the local optimum. Thus, bots could be used to test how ‘disruptors’ can shift the behaviour of a population in coordination problems.

Noisy play — making mistakes or experimenting with strategies — is also important for the evolution of social outcomes in models of cooperation and coordination based on evolutionary game theory[4–7] (a theoretical framework in which strategic behaviours can be analysed in the context of evolutionary selection pressure). It is therefore instructive to compare Shirado and Christakis’s network-based problem with game-theory-based approaches to the study of coordination, such as games in which some endpoints have greater rewards than others[8–10].

As a classic game-theoretic example, consider a game in which two players decide simultaneously whether to hunt a stag or a rabbit. Only if both go for the optimal choice, the stag, will they catch it; if one hunter chooses the stag and the other the rabbit, the first gets nothing, but the second gets a rabbit. In this type of game, attempting to coordinate to achieve a collectively optimal solution exposes players to the risk of a loss. Players might therefore opt for a collectively inefficient but safer endpoint, both choosing the rabbit.

Game-theory-based models in which players occasionally make mistakes predict an inefficient outcome for these games[4,5]. Experimental evidence confirms this prediction, particularly in large groups in which everyone must play the game with each other person[11]. But interestingly, efficient coordination can often be achieved if these games are played on large networks in which each person plays only with their neighbours. Here, success becomes more likely as the network becomes more centralized — that is, the more links players have to others[12,13].

This suggests a parallel to the current study, in which centralized bots improve global coordination. Thus, central players are crucial for success in both game theory and networked coordination problems. However, a key difference is that most game-theoretic analyses focus on local interactions, whereas Shirado and Christakis focus on coordination success across the whole network.

An interesting avenue for future research could therefore be to combine Shirado and Christakis's network approach with incentives for both local and global coordination. This could provide a more-realistic model for interaction structures in many real-world local–global coordination problems (such as in integrated supply chains or large organizations), in which people have local incentives for coordination. These incentives might make them unwilling to move away from a locally optimal decision to achieve global coordination, much like the hunters who have an incentive to go alone for the rabbit. The authors' approach could be broadly applied to help determine the location and level of noise required to obtain the desired outcome in various networks, testing the effects of differences in both centrality and incentives for local and global coordination.

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Support under ERC-AdG 295707 COOPERATION is gratefully acknowledged.

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FIGURE 1

https://www.nature.com/nature/journal/v545/n7654/fig_tab/545297a_F1.html

Figure 1 | Noise helps resolve coordination problems. a, Shirado and Christakis[2] set up networks of nodes of three colours, such as in this simplified example. Nodes were assigned to a human player, or sometimes to an automated software agent called a bot. Players aimed to coordinate such that each node was a different colour to each of its neighbours (colour conflicts are indicated by red lines). **b**, Players could only see the colour choices of their neighbours, and so players (such as the one starred) could remove local colour conflicts without solving all conflicts globally. Some conflicts were locally unsolvable (such as that of the circled player). Bots played optimally most of the time, but were programmed to make random colour choices a certain percentage of the time, as here, introducing noise into the network. **c**, This noise helped resolve colour conflicts — in this instance by encouraging a player (triangle) to change colour, enabling the circled player to resolve their conflict.