

# Experiments in dynamic group action and decision making: How crowds of people can walk a tightrope together and survive a zombie attack

**Daniel C. Richardson** ([dcr@eyethink.org](mailto:dcr@eyethink.org))

**Peter Riefer** ([peter.riefer.11@ucl.ac.uk](mailto:peter.riefer.11@ucl.ac.uk))

**Bradley Love** ([b.love@ucl.ac.uk](mailto:b.love@ucl.ac.uk))

Cognitive, Perceptual & Brain sciences, University College London  
Gower Street, London WC1E 6BT, United Kingdom

**Beau Lotto** ([lotto@ucl.ac.uk](mailto:lotto@ucl.ac.uk))

**Richard C. Clarke** ([richard.clarke@ucl.ac.uk](mailto:richard.clarke@ucl.ac.uk))

Institute of Ophthalmology, University College London,  
11-43 Bath Street, London EC1V 9EL, United Kingdom

**Rick Dale** ([rdale@ucmerced.edu](mailto:rdale@ucmerced.edu))

Cognitive & Information Sciences  
University of California, Merced, CA 95343, USA

**John Rogers** ([john@delosis.com](mailto:john@delosis.com))

**James Ireland** ([james@delosis.com](mailto:james@delosis.com))

Delosis, 8 Grosvenor Road, Twickenham, Middlesex TW1 4AE, United Kingdom

**Keywords:** joint action; wisdom of crowds; group behaviour, situated cognition; decision making; public goods games

We present results from a new paradigm: mass participation games. In our experiments, hundreds of people can play a computer game simultaneously using audience response handsets. We can collect responses from a lecture hall full of people with the precision of a laboratory cubicle. We have studied two games: continuous, action games where participants cooperate to achieve a goal; and decision-making paradigms in which participants make repeated choices to maximise their own or the group's rewards. We address a range of theoretical questions with experimental manipulations and computer modelling. Do participants play as if they were alone, or as a group? If so, do they represent the group as a single entity, or a collection of other agents? What are the dynamics of these behaviours, with learning across many trials? Lastly, what does it feel like to act in concert, or in competition, with a room full of people?

There is wisdom in a crowd. The averaged response of a crowd usually betters any of the individual guesses, whether they are guessing the weight of a cow (Galton, 1907), predicting the stock market or making bets about geopolitical events (Surowiecki, 2004). But is the superiority of crowds restricted to single, static decisions? There may be wisdom in a crowd but what happens when they have to *act* together? What happens when they have to make decisions - pervasive in society - that trade off their own interests with those of the group? For these actions and decisions to be made, how do they learn to predict the behaviour of the group? We addressed these questions by developing mass participation games, in which participants cooperate or compete, maximising their own rewards or those of the group <sup>1</sup>.

## Tightrope walking: a cooperative action game

In our first, action-based game participants saw on a projection screen a picture of a man holding a pole, balanced on rope (Figure 1). Each participant held a handset and pressed one of two buttons. A laptop computer collected the responses and controlled the movements of the tightrope walker. Each time one of the participants pressed a button, it sent a small nudge to the tightrope walker, sending him left or right. A game ended when the tightrope walker fell.

Analysing the time he stayed aloft and tracking individual responses, we found that on successful games participants were able to anticipate and compensate for the behaviour of the group. This conclusion was supported by agent based simulations. In later conditions we instructed the participants to vocalise their button presses as they made them. The evidence is that they made use of this information, and were better able to predict and compensate for each others' actions.

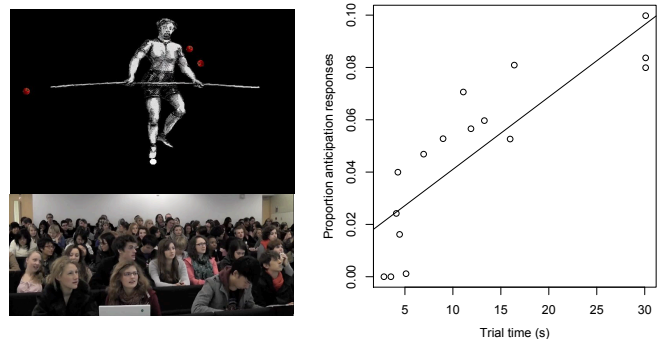


Figure 1. The tightrope walker game, the participants and the correlation between performance and anticipations

<sup>1</sup> If this paper is presented as a talk at the Cognitive Science conference, then the audience will of course be invited to play these games

## Zombie attack: A public goods game

Our second mass participation game studied decision-making in a public goods game. A contribution tin in an office kitchen is a public goods game. If everyone contributes money each week, it will pay for everyone's coffee. But a single person could choose not to contribute: they would get free coffee. If everyone followed this strategy, then the whole system would collapse and there would be no coffee. The trade-off between private and public gain is at the heart of public goods games. They are a standard tool in economic theories, used as a model for a huge range of activity from traffic patterns to tax returns.

Most empirical studies of public goods games use a small number of participants or have a small number of trials. We believe these miss the essential character of decisions made outside of the laboratory. People make these choices continuously throughout their lives, within the context of a social interaction. To understand how they learn to anticipate the actions of others, to see how social forces sway the choice to be selfish or cooperative, we argue it is vital to study the behaviour of a large group of people, present in a room together, playing repeated trials over time.

In our Zombie attack game, participants made a binary choice on each trial (Figure 2). They pressed one button to hide from the zombies, and another to fight. Rewards for the individual and the group decreased as more people chose to hide, but increased as more people chose to fight. Feedback on groups' decisions and rewards were shown. In one condition, they were told how many people had changed their choice from the previous game. Over the course of 25 games, we found that the switching feedback influenced strategies: without it, more people chose to fight. Though fighters always score less than hidiers individually, group scores increased across the no feedback group. This was because the higher number of fighters increased the scores of those who chose to hide too. This pattern of results shows that participants are not just making a rational decision about the relative rewards, but also making a social decision that is shaped by the perceived actions of others.

## Future Directions

We continue to collect data with these paradigms to answer a range of questions. Does the size of the group influence the group dynamics? How are participants learning about each others' behaviour and shaping their actions? We are answering these question by manipulating the information participants have about each other, and by developing computer models of the process. Lastly, we are interested in the social phenomenology of group dynamics. What social forces might shape group cohesion? How does it feel to be part of a successful, coordinated group? Anecdotal evidence suggest that there are complex issues at play. During one zombie game, a small group stood up and shouted, 'Everyone fight! Stand up if you are fighting!'. But later, in debriefing, members of the group admitted they were all choosing to hide and maximise their individual rewards. Clearly, though the games themselves are simple, more research is required to understand the choices made when they are played in the context of mass participation.

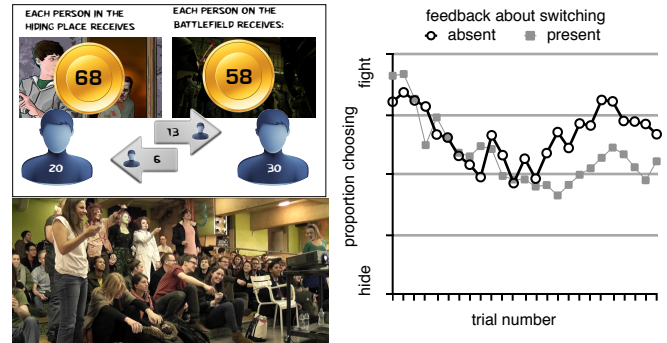


Figure 2. The zombie feedback screen, participants playing the game, and the relationship between feedback on switching behaviour and group decisions.

## Relevant publications of authors

### Decision making and modelling

- Knox, W.B., Otto, A.R., Stone, P., & Love, B.C. (2012). The Nature of Belief-Directed Exploratory Choice in Human Decision-Making. *Frontiers in Psychology*, 2, 398.
- Otto, A.R., & Love, B.C. (2010). You Don't Want To Know What You're Missing: When Information about Forgone Rewards Impedes Dynamic Decision Making. *Judgment and Decision Making*, 5, 1-10.
- Otto, A.R., Gureckis, T.M., Markman, A.B., & Love, B.C. (2009). Navigating through Abstract Decision Spaces: Evaluating the Role of State Generalization in a Dynamic Decision-Making Task. *Psychonomic Bulletin & Review*, 16, 957-963.
- Gureckis, T. M., & Love, B. C. (2009). Short Term Gains, Long Term Pains: Reinforcement Learning in Dynamic Environments. *Cognition*, 113, 293-313.
- Gureckis, T. M., & Love, B. C. (2009). Learning in Noise: Dynamic Decision-Making in a Variable Environment. *Journal of Mathematical Psychology*, 150, 180-193.

### Interpersonal coordination

- Richardson, D.C., Dale, R., & Kirkham, N.Z. (2007). The art of conversation is coordination: Common ground and the coupling of eye movements during dialogue. *Psychological Science*, 18(5), 407-413.
- Richardson, D.C., Dale, R., & Tomlinson, J.M. (2009). Conversation, gaze coordination, and beliefs about visual context. *Cognitive Science*, 33(8), 1468-1482.
- Richardson, D. C., Street, C. N. H., Tan, J. Y. M., Kirkham, N. Z., Hoover, M. A., & Ghane Cavanaugh, A. (2012). Joint perception: gaze and social context. *Frontiers in Human Neuroscience*, 6
- Dale, R., Kirkham, N.Z., & Richardson D.C. (2011). The Dynamics of Reference and Shared Visual Attention, *Frontiers in Cognition*.
- Richardson, D. C., Dale, R., Rogers, J., & Ireland J. (2011). How do 100 people walk a tightrope together? An experiment in large scale joint action. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*, Austin, TX: Cognitive Science Society.