Confidence in Interactive Decisions

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ECONOMIC
& SOCIAL
RESEARCH
COUNCIL

The research output of this grant was rated "Outstanding" by all three independent rapporteurs in the ESRC's research quality evaluation, 28 April 2006

Funding body

This largely experimental project, funded by the Economic and Social Research Council of the UK (ESRC) and based at the University of Leicester, tackles a number of interlinked questions about confidence in interactive decisions, drawing on theoretical ideas from behavioural economics and cognitive psychology.

Start Date: September 2003
End Date: August 2005

End-of-Project Symposium, 01 July 2005

Economic and Social Research Council grant £121,563 for 'Confidence in Interactive Decisions', to A. M. Colman, B. D. Pulford & F. Bolger. RES-000-23-0154.

SUMMARY:

► One study investigated *asymmetric dominance* effects in games. In individual decision making, when an agent chooses between alternatives *x* and *y*, the availability of a third alternative *z*, to which the agent strictly prefers *x* but not *y*, tends to increase the agent's preference for *x*. We showed that an analogous phenomenon occurs in strategy selection in games in which one strategy strongly dominates a second but not a third.

► A second study focuses on *ambiguity aversion* – a tendency for decision makers to prefer risks with known odds of success to ambiguous prospects in which the probabilities are unknown, the most familiar example of this phenomenon being Ellsberg's paradox. We have modelled this phenomenon in games (strategic ambiguity aversion) and shown that it influences the actions of players in a variety of games.

► A third study focuses on overconfidence effects in chance-based and skill-based *market entry games*, designed to model decisions of entrepreneurs starting up new businesses.

► A fourth study seeks to provide the first empirical evidence on the *confidence heuristic* and, more generally, to examine the communication of confidence in interpersonal exchanges of uncertain information when players are motivated to achieve mutually beneficial outcomes in pure coordination games.

► A fifth and final study is devoted to testing recent theories of *team reasoning*, according to which decision makers are sometimes motivated by the common interests of a group, rather than their individual utilities, and the extent to which this is affected by their confidence that the other group members are also likely to be team reasoning.

These research findings have potential implications for training commercial and political decision makers and advising government ministers, health care professionals, and others regarding the most effective ways of framing public information on issues such as vaccination and environmental protection.

Selected Outputs

Bolger, F., Pulford, B. D., & Colman, A. M. (2008). Market entry decisions: Effects of absolute and relative confidence. *Experimental Psychology, 55,* 113-120. PDF 112 KB

Colman, A. M., Pulford, B. D., & Rose, J. (2008). Collective rationality in interactive decisions: Evidence for team reasoning. *Acta Psychologica, 128,* 387-397. [Target article] PDF 225 KB

Colman, A. M., Pulford, B. D., & Rose, J. (2008). Team reasoning and collective rationality: Piercing the veil of obviousness. *Acta Psychologica, 128,* 409-412. [Reply to commentaries] PDF 167 KB

Pulford, B. D., & Colman, A. M. (2008). Size doesn't really matter: Ambiguity aversion in Ellsberg urns with few balls. *Experimental Psychology, 55,* 31-37. PDF 107 KB

Colman, A. M. (2007). Love is not enough: Other-regarding preferences cannot explain payoff dominance in game theory. *Behavioral and Brain Sciences, 30,* 22-23. PDF 78 KB

Colman, A. M., Pulford, B. D., & Bolger, F. (2007). Asymmetric dominance and phantom decoy effects in games. *Organizational Behavior and Human Decision Processes, 104,* 193-206. PDF 297 KB

Pulford, B. D. (2009). Is luck on my side? Optimism, pessimism, and ambiguity aversion. *Quarterly Journal of Experimental Psychology, 62,* 1079-1087. PDF 420 KB

Pulford, B. D., & Colman, A. M. (2007). Ambiguous games: Evidence for strategic ambiguity aversion. *Quarterly Journal of Experimental Psychology, 60,* 1083-1100. PDF 208 KB

EXTERNAL COLLABORATORS

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CONFIDENCE IN INTERACTIVE DECISIONS (RES-000-23-0154): FINAL RESEARCH REPORT (December 2005)

Background

Scant attention has been paid to the role of confidence in interactive decisions. This project was designed to clarify the nature, functions, and phenomena of confidence in the five areas of interactive decision making described below. Starting from a hypothesis, based on scattered evidence, that uncertainty is an aversive mental state that undermines decision confidence, we conducted several experiments. The project was intended as a contribution to behavioural decision making and psychological game theory.

Market Entry Decisions

A market-entry game (MEG) simulates business start-ups in competitive markets. Group members make repeated decisions to enter or not to enter a market and are told only the number of entrants on each round. The payoff structure resembles real-world markets – diminishing payoffs with increasing numbers of entrants, net losses for some if market capacity is exceeded, and no profit or loss for non-entry. In experiments, the number of entrants converges quickly towards Nash equilibrium – the number for which none could have done better by staying out and none who stayed out could have done better by entering. This "rational" level of market entry evolves without communication among players, as if by magic, as Kahneman famously commented.

In stark contrast, real-world business start-ups typically exceed market capacity, resulting in most new businesses failing within a few years. Camerer and Lovallo (1999) suggested that real-world over-entry may occur because payoffs depend partly on skill. They reported a MEG experiment in which, on some rounds, payoffs depended partly on players' skill, as measured by a general-knowledge quiz, and on other rounds were determined randomly, as in a standard MEG. Excess entry occurred only on the skill-based rounds, suggesting that players, and real-world entrepreneurs, enter too frequently through *overconfidence* about their skill levels.

We designed a MEG experiment to test this hypothesis more rigorously. We manipulated and measured confidence – which Camerer and Lovallo (1999) failed to do, thereby leaving their results open to alternative explanations. We distinguished between inflated self-evaluation relative to others (*relative overconfidence*) and inflated self-evaluation independent of interpersonal comparison (*absolute overconfidence*), a distinction ignored in standard measures of overconfidence, and we investigated their separate effects on entry decisions.

The Confidence Heuristic

According to Thomas and McFadyen's (1995) *confidence heuristic*, when people communicate beliefs to one another, they tend to express degrees of confidence proportional to their degrees of certainty, and recipients tend to judge the reliability of the information according to the confidence with which it is expressed. Thomas and McFadyen proved that this heuristic permits efficient exchange of information between decision makers with common interests and implements optimal solutions in pure coordination games with incomplete information – in which players have coinciding interests, so they are motivated to coordinate their actions, but incomplete knowledge of the payoffs structure. The theory appears never to have been tested empirically, and we therefore designed two experiments to plug this gap.

Team Reasoning

Decision theory and game theory rest on an assumption of *methodological individualism*, according to which agents invariably act to maximize their individual expected utilities. But people may sometimes act to maximize the *collective* utility of their group. This is *team reasoning*, and a small body of literature focuses on its surprisingly radical implications (e.g., Bacharach, 1999, 2005; Sugden, 1993, 2005). In Bacharach's stochastic theory, agents adopt team reasoning only if they are confident that other group members will do so also.

Team reasoning involves collective preferences, which may not coincide with any group member's individual preferences, and a special mode of reasoning from preferences to choices: first compute a profile of strategies that maximizes the payoff of the group; then, if this profile is unique, choose the corresponding strategy. Orthodox decision theory is a special case in which the group is a singleton. Theories of team reasoning elucidate phenomena such as payoff dominance.

No one has provided experimental evidence for team reasoning nor even collective preferences. Our experiment sought evidence for both, using decision scenarios and games with significant cash payoffs. Our experimental games each had a unique Nash equilibrium and a unique *out-of-equilibrium* outcome maximizing the collective payoff. This experiment pitted orthodox game theory head-on against team reasoning.

Asymmetric Dominance in Games

When a person chooses between *x* and *y*, the availability of a third alternative *z*, to which the person strictly prefers *x* but not *y*, tends to increase the person's preference for *x*. This is the *asymmetric dominance* effect (Huber, Payne, & Puto, 1982). For example, if a shopper is indifferent between a mobile phone *x* (cost £120, call charges 15p per minute) and another *y* (cost £100, call charges 25p per minute), then the availability of *z* (cost £140, call charges 20p per minute) may cause the shopper to prefer *x* to *y*, because *x* is cheaper than *z* on both product attributes, whereas *y* is not. This effect persists even if the dominated alternative *z* is presented as a "phantom decoy", like an unavailable item on a menu or catalogue.

We hypothesize that asymmetric dominance operates by bolstering confidence – one feels more confident choosing an option that is seen to be unambiguously better than something else. We showed how it might apply to games, and we carried out two experiments to investigate it. Player I always had a strategy strongly dominating one other – yielding a better payoff against every possible co-player strategy. We examined strategy choices when the dominated strategies were phantom decoys and when they were available for choice, compared to choices in a control condition with dominated strategies deleted.

Strategic Ambiguity Aversion

We identified a class of *ambiguous games*, in which players cannot assign meaningful probabilities to co-players' strategies, and we explored a phenomenon that we called *strategic ambiguity aversion* – a tendency to prefer *known-risk games* (in which meaningful probabilities can be assigned) to ambiguous games.

Individual-choice ambiguity aversion was discovered by Ellsberg (1961). Two urns are filled with red and black balls. Urn *A* contains 50 red and 50 black balls, Urn *B* an unknown ratio of 100 red and black balls. A decision maker chooses a colour and an urn, then draws a ball and wins a prize if it is the right colour. Most people strictly prefer the known-risk Urn *A*, irrespective of the chosen colour, even when they know the *second-order probabilities* of the ambiguous option – for example, when they do not know the ratio of red to black balls in Urn *B* but know that every possible ratio is equally likely.

We modelled strategic ambiguity aversion following Harsanyi's (1967-1968) technique for modelling incomplete information. We proposed a new interpretation of ambiguity aversion based on intolerance of uncertainty and loss of confidence, and we conducted an experiment designed to discover evidence for strategic ambiguity aversion and to test our interpretation of it. (We also performed an experiment using small Ellsberg urns to test an influential alternative theory, but we lack the space to discuss it here.)

Objectives

The project's aim was to integrate ideas from behavioural economics and cognitive psychology through experiments on aspects of confidence in interactive decisions. We ran more experiments than planned, with over 700 participants, and we met and exceeded the following objectives.

1. To assess the role of overconfidence in market entry decisions, taking account of different types and measures of overconfidence. This was addressed through an experiment in which confidence was manipulated and measured in a market entry game and different measures of overconfidence were distinguished.

2. To test assumptions underlying the confidence heuristic, and to examine the communication of confidence in interactive decisions. This was addressed by

developing an operational interpretation of the confidence heuristic and conducting two experiments on communication of confidence in pure coordination games with incomplete information.

3. To test key assumptions of the theory of team reasoning, seeking empirical evidence for collective preferences and team-reasoning decisions. This was addressed through an experiment on collective preferences in decision scenarios and team reasoning in dyadic games.

4. To examine the asymmetric dominance effect in strategic games, and to seek empirical evidence for hypothesized confidence effects underlying it. This was addressed by modelling asymmetric dominance in games and performing two experiments involving games with asymmetrically dominated strategies.

5. To seek evidence for strategic ambiguity aversion, and to examine the role of confidence in explaining it. This was addressed through the identification of a class of ambiguous games, the development of a formal model of strategic ambiguity aversion, and an experiment designed to seek evidence for it and for a confidence-based interpretation of it.

Methods and Results

The methods included theoretical developments and controlled experiments. Participants (subjects) were recruited via an on-line participant panel and were paid significant rewards (typically, between £5 and £15) according to payoffs earned in the experiment. Detailed methods and results varied between experiments, hence for clarity of exposition we have conjoined “methods” and “results” into one heading and grouped specific details under sub-headings below.

Market Entry Decisions

The 96 participants, assigned to 16-member groups, played 24 rounds of a MEG. To increase player involvement, motivation, and comprehension, we presented it as a simulation of 24 opportunities to open restaurants in small or large towns (depending on market capacities of 4 or 8). On every round, players rated their decision confidence on a 0–100 scale.

On 12 *random rounds*, whenever market capacity was exceeded, winners and losers were selected randomly, and on 12 *skill-based rounds*, rankings on a quiz were used to select winners and losers when market capacity was exceeded. The quiz required participants to choose, from pairs of UK companies, which produced more profit the previous year. This was intended to have higher face validity as a measure of entrepreneurial skill, and hence more potential for manipulating confidence in the MEG, than general-knowledge quizzes used in previous research.

We manipulated confidence before the MEG by showing the players examples of the types of questions they could expect in the quiz that would determine their rankings.

We assigned participants randomly to easy or hard examples, as calibrated in a pilot study. The main quiz – the same for all participants – was moderately hard. Group size (fixed) and order effects (counterbalanced) were more rigorously controlled than in Camerer and Lovallo's (1999) experiment.

Results. The confidence manipulation shifted confidence significantly in the predicted direction. On skill-based rounds, entry decisions were significantly more frequent when confidence was high, providing independent corroboration of the overconfidence hypothesis and putting it on a firmer empirical foundation. Entry decisions on skill-based rounds were better predicted by absolute than relative overconfidence, clarifying the overconfidence effect and the confusion arising from neglect of this distinction in measurements of overconfidence.

The Confidence Heuristic

First experiment. Working in dyads on a specially devised Police and Suspects game, 56 participants attempted to determine which face, from an array of nine photographs, looked most like a suspect portrayed in an E-fit. On each of 16 trials, one participant was shown a good E-fit likeness of one of the faces, designed to induce high confidence and accuracy, while the other was shown a weak E-fit likeness of another face. Participants could not see each other's E-fits but were allowed two minutes to discuss their E-fitsand decide which suspect to choose. We chose this task because of the notorious difficulty of expressing in words why one face resembles another. The strong likeness was given to one player on eight trials and to the other on the other eight. Each E-fit was shown once to Player I and once to Player II on different trials, enabling us to determine, with full control of extraneous factors associated with particular faces, the proportion of trials on which players with strong likenesses won the argument.

Whenever both players chose the correct face, they received 40p each. Whenever they both chose the same incorrect face, they received 20p each. Whenever they chose different faces, neither received anything, even if one was right. These payoffs define a Hi–Lo type of pure coordination matching game. Players indicated on a 0–100 scale how confident they felt that they had selected the correct face. We investigated the effects of the gender and individual differences such as assertiveness, need for cognition, need for closure, and overconfidence.

Results: first experiment. Players disagreed on less than 8% of trials, and half the pairs always agreed. This was unsurprising, given the pure coordination payoff structure. The proportion of trials on which the player with the strong likeness persuaded the co-player to agree on the correct face was significantly higher than the proportion on which the player with the weak likeness persuaded the co-player to agree on the incorrect face. As far as we know, this is the first empirical evidence for the confidence heuristic. However, because players with weak likenesses were quite often persuasive, communication of confidence is evidently more complex than the heuristic implies, and other factors affect coordination under incomplete information.

Second experiment. To cross-check the findings in a different domain, we replicated the first experiment using a size discrimination task. Each of 82 participants decided which of two shapes (e.g., squares, circles, diamonds) was closest in size to a similar target shape and discussed with a co-player which one to choose. For one player, the target fell midway between the two in size, generating low confidence, and for the other it was close to one of the shapes, generating high confidence and choice accuracy.

Results: second experiment. The player with the stronger evidence persuaded the co-player on 86% of trials, providing further evidence for the confidence heuristic and the ability of people to communicate and interpret confidence.

Team Reasoning

First part. To provide empirical evidence for collective preferences, 81 participants made ten decisions and rated their confidence, choosing in each case from a list of five options for assigning real monetary payoffs to themselves and an unidentified partner. Every decision was framed as a scenario designed to engage a *social value orientation*: (a) individualistic (maximizing own payoff), (b) altruistic (maximizing co-player's payoff), (c) equality-seeking (minimizing difference between own and co-player's payoff), (d) competitive (maximizing difference between own and co-player's payoff), or (e) collective (maximizing joint payoff). Options (a) to (d) are social value orientations in the sense of van Lange (1999), and (e) is a team-reasoning orientation that (we proved) cannot be formulated within van Lange's theory.

Displayed below is one of the scenarios designed to engage collective preferences, with the collective option at c. In spite of the scenario framing, participants knew that the numbers represented pounds sterling for themselves and their partner and that one scenario would be chosen randomly for actual payments.

Fund-raising

You and other students collect funds for charity. In the first hour, you and your best friend each raise some money. Here is a list of the possible options:

	You raise	Friend raises
Option a	£1	£7
Option b	£3	£3
Option c	£5	£6
Option d	£6	£4
Option e	£4	£1

Which option do you prefer? a b c d e (circle one)

The response alternatives were invariably mutually exclusive; for example, a response satisfying the individualistic orientation (e.g., d above) did not maximize any of the other orientations.

Results: first part. Preferences tended (weakly) to follow the social value orientations that the scenarios were designed to engage. Crucially, substantial proportions of decision makers chose the collective options (e.g., c above) in the two scenarios designed to engage collective preferences – 59% (Fund-raising) and 49% respectively – and much smaller proportions chose them in the other scenarios.

Second part. This was designed to provide evidence for team reasoning. The same participants made one-off decisions in four 2 × 2 and five 3 × 3 games, each having a unique Nash equilibrium and a unique, out-of-equilibrium outcome that maximized the dyad's collective payoff. In orthodox game theory, if a game has a unique Nash equilibrium, then rational players are bound to choose it, because only thus do they choose best replies to each other's strategies.

Below is a 3 × 3 game used in the experiment, with Nash equilibrium at (*E*, *E*) and team reasoning outcome at (*C*, *C*):

		II		
		C	***D***	***E***
I	***C***	**3, 3**	**0, 0**	**0, 4**
	D	**0, 0**	**1, 1**	**1, 2**
	E	**4, 0**	**2, 1**	**2, 2**

We rotated rows and columns and presented games to players in different random orders. The payoffs represented pounds sterling and one game was selected randomly for cash rewards.

Results: second part. In the 2 × 2 games, the percentages of team-reasoning strategy choices were 63%, 52%, 51%, and 53%. In the five 3 × 3 games, the percentages were 53%, 57%, 56%, 86%, and 54%. Thus, in every game in which team reasoning was pitted against Nash equilibrium, an absolute majority of players chose the team reasoning strategy. This provides strong evidence that team reasoning can influence decision making in certain games. Team reasoning predicted strategy choices more powerfully than orthodox game theory (Nash equilibrium).

Asymmetric Dominance in Games

Asymmetric dominance violates rational choice intuitively, but it is not immediately obvious why this is so. We proved that it violates Savage's first axiom, a fundamental property of rational choice. We also performed two experiments on asymmetric dominance in games.

First experiment. We assigned 72 participants randomly to three treatment conditions in pairs. In the first, players made one-off decisions in twelve symmetric 3 × 3 games in which each player had one strategy strongly dominating one other, but the dominated strategies were phantom decoys, visible but unavailable for choice. The second treatment condition was similar, except that the dominated strategies were available for choice. In the third (control) condition, players made decisions in twelve 2 × 2 games constructed by deleting the dominated row and column from each of the 3 × 3 games. The first condition is strategically equivalent to the control, and any difference in behaviour between the two must be a context effect induced by the phantom decoy. Under standard game-theoretic knowledge and rationality assumptions, the second condition is also strategically equivalent, because strongly dominated strategies are inadmissible for rational players.

One of the games is shown below. For both players, Strategy *C* dominates Strategy *E*.

		II		
		C	***D***	***E***
	C	**2, 2**	**4, 3**	**2, 1**
I	***D***	**3, 4**	**1, 1**	**0, 3**
	E	**1, 2**	**3, 0**	**1, 1**

Rows and columns were rotated to control for positional effects, and the games were presented in a different random order to each participant.

Results: first experiment. When the dominated strategy was available, only a handful of players ever chose it, providing reassurance that players understood the payoff matrices and the dominance relation. In line with our hypotheses, players chose dominant strategies more frequently – even when they dominated only phantom decoys – than in the control condition, where they did not dominate any strategies. However, the differences between these means were not quite significant, probably because of a ceiling effect in six of the 12 games. In the six games in which the strategy preferred by a majority in the 2 × 2 control condition was *not* the strategy arbitrarily chosen to dominate another strategy in the 3 × 3 extensions, the asymmetric dominance effect *was* statistically significant: the potentially dominant strategy was chosen by 25% in the control condition, 44% in the phantom dominance condition, and 54% in the full dominance condition, and the differences between these percentages is highly significant.

Second experiment. To provide more persuasive evidence, we replicated the experiment, starting with 12 new (asymmetric) 2 × 2 games without dominant strategies or pure-strategy equilibria. We generated 3 × 3 extensions by adding strategies asymmetrically dominated by the strategies that were predominantly *dis*preferred in a published experiment on choices in the 2 × 2 games (Rapoport, Guyer, & Gordon, 1976). One of the games is shown below – *C* dominates *E* for both players.

		II		
		C	***D***	***E***
I	***C***	**4, 3**	**1, 2**	**3, 2**
	D	**2, 1**	**3, 4**	**0, 0**
	E	**3, 3**	**0, 0**	**2, 2**

Rows, columns, and game presentation order were controlled as before. In this experiment, one participant serving as Player II throughout, was paired with each of 81 Player I participants. Only Player I choices were analysed.

Results: second experiment. Choices of potentially or actually dominant strategies across the three treatment conditions differed significantly in the hypothesized direction. The phantom decoy and full asymmetric dominance conditions did not differ significantly, but both of those conditions elicited significantly more *C* strategy choices than the control condition, in which it was not dominant. This confirms that asymmetric dominance can influence strategy choices in games, even when it is only a phantom decoy framing effect. The phenomenon is consistent with our confidence-bolstering interpretation.

Strategic Ambiguity Aversion

In the role of Player I, 195 participants played three 2 × 2, three 3 × 3, and three 4 × 4 games presented as shown below. Five further participants served as Player II types.

A

		II	
		C	***D***
I	***C***	**8, 4**	**0, 4**
	D	**0, 4**	**8, 4**

B

		II			II	
		C	***D***		***C***	***D***
I	***C***	**8, 4**	**0, 0**		**8, 0**	**0, 4**
	D	**0, 4**	**8, 0**		**0, 0**	**8, 4**

Player I participants first chose whether to play the known-risk version with a co-player from Group *A*, whose payoff function invariably showed Player II to be indifferent between strategies (having an identical expected payoff for any strategy choice), so that Player I could reasonably assign equal probabilities to Player II's strategies, or with a co-player from Group *B*, containing two or more Player II types, each having a different dominant strategy that would obviously be chosen by that type. Half the participants were told that the Player II types in Group *B* were equally likely, and half that any distribution of Player II types was possible. Half the participants expected the

outcomes to be known immediately, and half expected a week's delay. We hypothesized that ambiguity aversion would be greater when a delay was anticipated, because the aversive effects of uncertainty would be expected to last longer.

Results. Players chose known-risk games in 59% of cases, confirming a significant strategic ambiguity aversion effect. The effect was strongest (64%) for players presented with the most ambiguous Group *B* alternatives, without second-order probability (equal likelihood) information. In this condition, the effect was separately significant in seven of the nine games. In the delay conditions, players who knew that the ambiguous co-player types were equally likely were significantly less ambiguity-averse than those who did not, an effect that we interpreted in terms of uncertainty avoidance and confidence loss.

Activities

Grant-funded Symposium

We organized a one-day symposium on "Confidence in Interactive Decisions" at the University of Leicester on 1 July 2005. Some 30 people attended, and we invited and sponsored leading authorities from the UK, the US, and Europe.

The three grant-holders each presented papers describing work on the project. The other keynote speakers were Nigel Harvey (University College London), Eldar Shafir (Princeton University), Robert Sugden (University of East Anglia), Karl Teigen (University of Oslo), Paul van Lange (Free University of Amsterdam), Mark van Vugt (University of Kent at Canterbury), and Daniel Zizzo (University of East Anglia).

Conference and workshop presentations

Bolger, F., Colman, A. M., & Pulford, B. D. (2004). *Effects of positive biases on decisions to enter a competitive market.* Paper, 20th Research Conference on Subjective Probability, Utility, and Decision Making (SPUDM20), Stockholm, August 22–24, 2005.

Bolger, F., Colman, A. M., & Pulford, B. D. (2004). *Effects of positive biases on market entry*. Paper, FUR XI conference, Paris, 30 June–3 July 2004.

Bolger, F., Colman, A. M., & Pulford, B. D. (2005). *Effects of positive biases on decisions to enter a competitive market*. Keynote paper, Confidence in Interactive Decisions Symposium, Leicester, July 1, 2005.

Bolger, F., Pulford, B. D. & Colman, A. M. (2005). *Effects of positive biases on decisions to enter a competitive market*. Poster, 26th Annual Conference of the Society for Judgment and Decision Making. Toronto, Canada, November 11–14, 2005.

Colman, A. M., & Pulford, B. D. (2005). *Strategic ambiguity aversion*. Paper, 20th Research Conference on Subjective Probability, Utility, and Decision Making (SPUDM20), Stockholm, August 22–24, 2005.

Colman, A. M., & Pulford, B. D. (2005). *Ambiguous games*. Keynote paper, International Conference of Cognitive Economics, Sofia, 5–8 August 2005.

Colman, A. M., Pulford, B. D., & Bolger, F. (2004). *Asymmetric dominance and confidence in mixed-motive dyadic games*. Seminar, Oxford Experimental Economics Workshop, University of Oxford, 13 May 2004.

Colman, A. M., Pulford, B. D., & Bolger, F. (2004). *Asymmetric dominance and confidence in mixed-motive dyadic games.* Paper, FUR XI conference, Paris, 30 June–3 July 2004.

Colman, A. M., Pulford, B. D., & Bolger, F. (2005). *Asymmetric dominance effects in games.* Keynote paper, Confidence in Interactive Decisions Symposium, Leicester, July 1, 2005.

Colman, A. M., Pulford, B. D., & Bolger, F. (2005). Asymmetric dominance and confidence in strategic interaction. Paper, British Psychological Society Quinquennial Conference, Manchester, 30 March – 2 April 2005.

Colman, A. M., Pulford, B. D., & Bolger, F.(2005). *Asymmetric dominance in dyadic experimental games.* Paper, Midlands Game Theory Workshop, Keele University, 3 May 2005.

Pulford, B. D. (2004). *Exploring confidence*. Invited speaker, “Women in Management” series. University of Wolverhampton, 3 November 2004.

Pulford, B. D., & Colman, A. M. (2005). *Testing the confidence heuristic: Are confident communicators more persuasive*? Keynote paper, Confidence in Interactive Decisions Symposium, Leicester, July 1, 2005.

Pulford, B. D., & Colman, A. M. (2005). *Testing the confidence heuristic: Are confident communicators more persuasive*? Paper, 20th Research Conference on Subjective Probability, Utility, and Decision Making (SPUDM20), Stockholm, August 22–24, 2005.

Pulford, B. D., & Colman, A. M. (2005). *Testing the confidence heuristic: Are confident communicators more persuasive?* Paper, British Psychological Society Quinquennial Conference, Manchester, 30 March – 2 April 2005.

Outputs

Seven datasets have been created and offered to the Data Archive. Listed below are outputs to date.

Bolger, F., Pulford, B. D., & Colman, A. M. (in preparation). Market entry decisions: Effects of positive biases.

Colman, A. M., & Pulford, B. D. (2005). Ambiguous games and strategic ambiguity aversion. In B. Kokinov (Ed.), *Advances in cognitive economics: Proceedings of the international conference on cognitive economics, Sofia, August 5–8, 2005* (pp. 32–44). Sofia: NBU Press.

Colman, A. M., Pulford, B. D., & Bolger, F. (2005). Asymmetric dominance and confidence in strategic interaction [Abstract]. *Proceedings of the British Psychological Society, 13*(2), 207.

Colman, A. M., Pulford, B. D., & Bolger, F. (in preparation). Asymmetric dominance effects in dyadic experimental games.

Colman, A. M., Pulford, B. D., & Park, J. R. (in preparation). Team reasoning: Experimental evidence.

Park, J. R., & Colman, A. M. (under review). Team preferences in interactive decision making: Maximizing collective utility. (submitted to *Theory and Decision*)

Pulford, B. D. (under review). Is luck on my side? Optimism, pessimism and ambiguity aversion. (submitted to *Personality and Individual Differences*)

Pulford, B. D. & Colman, A. M. (under review). Ambiguous games: Evidence for strategic ambiguity aversion. (submitted to *Quarterly Journal of Experimental Psychology*)

Pulford, B. D. & Colman, A. M. (under review). Size does not really matter: Ambiguity aversion in Ellsberg urns with few balls. (submitted to *Quarterly Journal of Experimental Psychology*)

Pulford, B. D. & Colman, A. M. (in preparation). Testing the confidence heuristic.

Pulford, B. D., & Colman, A. M. (2005). Testing the confidence heuristic: Are confident communicators more persuasive? [Abstract]. *Proceedings of the British Psychological Society, 13*(2), 160.

Pulford, B. D. & Colman, A. M. (under review). Undermining Confidence: Uncertainty Intolerance and Ambiguity Aversion (submitted to *Personality and Individual Differences*)

Impacts

Both of our papers at the BPS Quinquennial Conference were press released, and there was some interest from the media.

Future Research Priorities
All of the lines of research initiated by this project are well worth pursuing. We have made some significant discoveries, but much remains to be done.

References
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Ethics
The research complied fully with the British Psychological Society’s *Ethical Principles for Conducting Research with Human Participants* (2004) and was formally approved by the Ethics Committee of the University of Leicester School of Psychology. No deception was used, and participants were offered full debriefing.

Comment
The budget was underspent by a few thousand pounds for the following reasons. (a) Lecturers budgeted to replace Dr Pulford were appointed after their planned start dates, and one left early. (b) After Dr Pulford moved to the University of Leicester in September 2004, money earmarked for commuting from Wolverhampton was unspent. (c) Two grant-holders attended the British Psychological Society's Millennium Conference for only one day without residence instead of the full four-day duration.