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Research Grants PROPOSAL

Document Status: In Submitter Pool
ESRC Reference:

Research Grants (Open Call)

Organisation where the Grant would be held

Organisation	University of Warwick	Research Organisation Reference:	Accumulation
Division or Department	Psychology		

Project Title [up to 150 chars]

Accumulating to choose, but accumulating what? Drift diffusion modelling of economic preference

Start Date and Duration

a. Proposed start date	03 April 2016	b. Duration of the grant (months)	36

Applicants

Role	Name	Organisation	Division or Department	How many hours a week will the investigator work on the project?
Principal Investigator	Professor Neil Stewart	University of Warwick	Psychology	11.25
Co-Investigator	Professor Chris Starmer	University of Nottingham	Sch of Economics	3.75

Classification

International in nature? Yes

Please give details

The research is a collaboration between the Universities of Warwick and Nottingham with Caltech.

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Proposal original proforma document

Objectives

List the main objectives of the proposed research [up to 4000 chars]

During a choice, how does evidence build up over time until the choice is made? Alternating attention across choice alternatives while deliberating---thinking at one instance about the sweetness of the chocolate and the next about the crunchiness of the apple---is common across all economic choices. The alternating attention, measured using eye tracking, provides rich evidence for developing choice theory and for application in real economic choices.

We have three core objectives:

1. Create a shareable data set of eye movement recordings collected during choice. In six experiment series, we provide direct tests of a key model of the accumulation of evidence during economic choices, the attentional drift diffusion model. Data will be deposited in the UK Data Service and available to researchers across the world.

2. To develop a complete theory of the link between attention and choice. The theory will be implemented as a computational model which makes predictions about choice and the allocation of attention as operationalised by the eye movements made during a choice. Publication will be across Psychology and Economics.

3. To translate the scientific research into impact in consumer choices in collaboration with the Financial Conduct Authority, the UK credit card industry, the Economic and Social Research Institute, and the consumer group Which?. We will deliver a set of field experiments on industry-driven issues aimed directly at providing an evidence base for regulation decisions and commercial decisions. We will report findings in industry publications.

Summary

Describe the proposed research in simple terms in a way that could be publicised to a general audience [up to 4000 chars]

Imagine choosing between an apple and some chocolate. In one instant you will be thinking about the lovely, crunchy apple. The next you are thinking about the smooth, indulgent chocolate. Your attention will dart back and forth between the apple and the chocolate until you make your mind up. This research is about exactly what is happening, at each instant, as you deliberate and choose. We will combine laboratory experiments (detailed in the Case for Support) and translational field experiments with real consumers making real choices (with our industry collaborators, detailed in the Pathways to Impact). Using eye-tracking technology, we will record millisecond-by-millisecond where people are looking as they choose. This will allow us to build an explanation of the link between attention and choice.

Psychology, Neuroscience, and Economics have developed a first-generation model based on some key findings. When someone is choosing they take time to deliberate and shift their attention back and forth repeatedly. We now know that people are likely to look more at the option they ultimately choose and that if we intervene to make people look more at one option they are more likely to choose it. This has led to the development of drift diffusion models. Although complicated, these models instantiate the following idea: While an individual is looking at a specific option, they are biased towards thinking about why they should choose that option. For example, if you are looking at the chocolate, you are more likely to be thinking about the chocolate and are edging towards choosing the chocolate. In the language of the model, we say you are drifting towards choosing the chocolate while attending to the chocolate. If the chocolate is really much nicer than the apple, you will chose it quickly. In the language of the model, you have a high drift rate. If the chocolate and the apple are pretty evenly matched, you will take ages to decide. In the language of the model, you have a low drift rate.

Now, when you look at the chocolate bar, we can't tell whether you are thinking about the sweetness, the high calories, or the pretty wrapper. So we asked people in our lab to choose between options with spatially separate attributes. For example, we had people choose between lotteries where the cash prize and the chance of winning were written separately, next to one another. We were surprised by the result. We found that looking more at a particular lottery was associated with choosing that lottery-just like with the chocolate. But this result did not hold for the separate attributes. You might expect people who looked more at the high cash prize to be more likely to pick the lottery and people who looked more at the low

chance of winning to be less likely to pick the lottery. But, across a whole series of experiments, looking at the bad properties of an alternative was just as strongly associated with choosing that alternative as looking at the good properties.

Our results show that while the link between what you are looking at and what you are thinking about is solid at the level of whole alternatives, it is broken at the level of the composite attributes. We need to rethink the model of how we choose. In the laboratory, we will replicate our findings across a wide number of tasks. We will test the effect of manipulating which attributes people look at. We will test for a feedback loop where looking increases drift rate, which in turn increases looking, and so on. The outcome will be new experimental evidence and new ideas about how we build up evidence over time to choose.

We will translate this laboratory research into the everyday, with real consumers choosing for real. By working with the Financial Conduct Authority, the regulator for consumer financial products, the UK credit card industry, and the Which? consumer group, we will implement field trials, demonstrating these effects in real choices and measuring their impact.

Academic Beneficiaries

Describe who will benefit from the research [up to 4000 chars].

This research will contribute to knowledge in a variety of fields. Right now the sequential sampling or drift diffusion models of choice are the most influential models within Psychology and Neuroeconomics. They are also gaining increasing attention within Economics as researchers investigate why individuals deviate from economically rational behaviour. Marketing researchers have also become more interested in these process focussed models as they look for more sophisticated methods of influencing choice and preference.

The results of this research will be of interest to Psychologists researching decision making and developing models of choice (e.g., the laboratories of Bogac and Summerfield, Oxford; Usher, Tel Aviv; Busemeyer, Indiana; Diederich, Jacobs; Brown, Newcastle; Glöckner, Göttingen; Shimojo, Caltech; Pleskac, Max Planck Institute for Human Development - Berlin). However, it will also inform a much wider community of researchers who perform behavioural research. This is because a large number of the most influential behavioural models have long held the assumption that attributes or items are weighted according to the proportion of attention they capture (e.g. decision field theory and the transfer of attention and exchange model). With the implementation of eye tracking it will be possible to test many of these hypotheses. Even where attention switching is assumed to be covert and within memory, these models must explain at least the difference in processing when some attributes are attended early on but others are only seen late in the choice process and can therefore not have been processed for as much of the deliberation time. It is also of interest to Psychologists working on models of perceptual choice (Usher, Tel Aviv; Tsetsos, Birkbeck). Many models of preferential choice originate from this percetual literature and there are still very strong links. Novel findings regarding information integration or attention biasing will be relevant to both fields.

As much of the early eye tracking work has come from neuroeconomics laboratories (Rangel, Krajbich, Camerer), these researchers will obviously be directly interested. Drift diffusion models of choice have become the most influential within neuroscience. This is because they can successfully link low level neuronal firing rates with higher level processes of evidence accumulation and decision times. They have now been applied across a variety of methodologies and interest only seems to be increasing, particularly within fMRI research. As the accuracy and availability of fMRI technology improves, tasks are becoming more complex and our findings will provide a framework for inevitable future neuroscience work. Furthermore, researchers are beginning to conduct eye tracking concurrently with other neuroscience methods such as fMRI and EEG (Lim, Philiastides). By laying a strong set of boundaries on the effects using eye tracking, it will be possible to design efficient and focussed experiments for these more expensive and time consuming techniques.

The marketing literature has become increasingly interested in eye tracking and visual attention. This is particularly due to the attention bias findings, where attention can be used to bias choice, which we use as our starting point here. The potential to be able to manipulate the choice process to bias preference aligns with a core aim of advertising and

marketing. New research on how this is best directed and the most efficient way of biasing choice will inevitably be of interest.

Staff Duties

Summarise the roles and responsibilities of each post for which funding is sought [up to 2000 characters]

All investigators will contribute to experimental design, analysis, theoretical development, and publication. In addition:

PI Neil Stewart (30% support requested, 3 years). Stewart will take overall responsibility for the delivery of all of the objectives of the grant. Stewart will also lead on the links to industry for the impact pathway. Stewart will also line manage Directly Incurred Posts (except Caltech).

PDRA Tim Mullett (100% support requested, 3 years). Mullett will be jointly responsible for the design of the experiments. Mullett will create the experiment programs using Matlab psychophysics toolbox and the Eyelink 1000 interface library. Mullett will be first author on the majority of publications. Mullett will manage a subset of the contacts for impact, in addition to developing the links with the supermarket.

CI Chris Starmer (10% support requested, 3 years). Starmer will contribute particularly on the development of drift diffusion models in risky choice and links to stochastic extensions of deterministic models.

CI Colin Camerer (no support requested, 3 years). Camerer will contribute in particular to eye tracking in social choice and contrast of the drift diffusion models with the leading level-k models of social choice.

PDRA Caltech (100% support requested, 1 year). A subset of experiments will be replicated at Caltech, and social choice experiments from Series 1, 5, and 6 will be based in this lab.
Lab manager (10% support requested, 3 years). The lab manager will provide support for setting up new experimental paradigms on the eye tracker. The lab manager will also manage the recruitment of participants to the laboratory.

RA (25% support requested, 3 years). The nature of eye tracking means participants must be tested one at a time. Testing 60 participants in an hour long study requires about two weeks. To free sufficient time for the PDRA to analyse data and write papers, support for testing participants is requested.

Impact Summary

Impact Summary (please refer to the help for guidance on what to consider when completing this section) [up to 4000 chars]

All financially active adults in the UK will benefit from regulation informed by the understanding of how people choose. The laboratory experiments detailed in the Case for Support include classic economic choices between risky lotteries, and the translational field experiments detailed in Pathways for Impact will involve real choices between financial products such as credit cards, bank accounts, mortgages, payday loans, and structured deposits. We will work with the Financial Conduct Authority to understand how presentation and marketing of financial products should be regulated to help consumers make fair and informed choices. The goal is to present complicated financial information in a format that can directly and most readily be incorporated by the natural evidence accumulation process. We will coauthor a paper in their Occasional Series (see Hunt, Stewart, & Zaliauskas, 2015, for example track record) to disseminate best practice to the consumer finance industry.

All those who shop for consumer goods, groceries, and services also stand to benefit from the research. With the consumer group Which? we will work to translate our laboratory findings on how people integrate information across the attributes of more complex choice objects into field trials testing different ways of presenting multi-attribute products to consumers (e.g., broadband providers with services differing in speed, caps, and cost). This would directly affect Which? subscribers. But beyond the subscription base, Which? offers a number of open services. For example, their birth choice website is visited by about half of all expectant mothers. Birth choice options include location (home, birth centre, labour

ward), pain relief (none, gas and air, epidural), and method (natural birth, caesarean). Field trials on information presentation, linked with actual birth choices months later, will help validate the long-term effects of decisions made and revisited for perhaps only tens of minutes.

We will also focus on credit card users, exploiting our strong links with the UK credit card industry (e.g., Navarro-Martinez et al., 2011). Cardholders must decide the amount of money to repay each month. Sometimes this is a one-off decision taken when a direct debit is set up. Understanding how evidence is accumulated for different options offered in the card activation telephone call can help us shape the timing and delivery of information. Evidence suggests that most cardholders would benefit from setting up a direct debit for more than the minimum payment, but many set up minimum payment only direct debits. Other cardholders choose monthly how much they repay. The design and presentation of bills and web pages will be informed by the laboratory studies and tested in further randomised control field trials. We will also have a particular focus upon those in difficulty, conducting translational field studies on their debt repayment options.

Letters of support are included from the Financial Conduct Authority (the UK financial regulator), Which? (consumer champion and campaign group), the UK Cards Association (the trade body for the UK payments industry), and the Economic and Social Research Institute.

Ethical Information

Has consideration been given to any ethical matters raised by this proposal ? Yes

Please explain what, if any, ethical issues you believe are relevant to the proposed research project, and which ethical approvals have been obtained, or will be sought if the project is funded? If you believe that an ethics review is not necessary, please explain your view (available: 4000 characters)

Full consideration has been given to ethical matters, and ethical approval has been granted by the University of Warwick Humanities and Social Sciences Research Ethics Committee. The committee considered the complete eye-tracking methodology, recruitment, (lack of) deception, (non involvement) of vulnerable participants, potential harms and benefits from participation including participant payments, data storage, privacy and confidentiality, reporting of results in journals and their wider dissemination, and the information provided to participants to gain consent to their participation. Separate ethical approval will be sought for the impact projects developed with the FCA, Which? and UK Cards as the specific details are set.

Summary of Resources Required for Project

Financial resources

Summary fund heading	Fund heading	Full economic Cost	ESRC contribution	% ESRC contribution
Directly Incurred	Staff	148722.00	118977.60	80
	Travel & Subsistence	25100.00	20080.00	80
	Other Costs	27000.00	21600.00	80
	Sub-total	**200822.00**	**160657.60**	
Directly Allocated	Investigators	140069.00	112055.20	80
	Estates Costs	30575.00	24460.00	80
	Other Directly Allocated	11572.00	9257.60	80
	Sub-total	**182216.00**	**145772.80**	
Indirect Costs	Indirect Costs	196820.00	157456.00	80
Exceptions	Staff	0.00	0.00	100
	Other Costs	45000.00	45000.00	100
	Sub-total	**45000.00**	**45000.00**	
	Total	**624858.00**	**508886.40**	

Summary of staff effort requested

	Months
Investigator	14.25
Researcher	45
Technician	0
Other	0
Visiting Researcher	0
Student	0
Total	59.25

Other Support

Details of support sought or received from any other source for this or other research in the same field.
Other support is not relevant to this application.

Previous Proposals

Enter the ESRC reference numbers of any support sought or received from ESRC in the past five years.	ES/N005546/1 ES/K002201/1 ES/F02598X/1 ES/I038373/1

Staff

Directly Incurred Posts

			EFFORT ON PROJECT							
Role	**Name /Post Identifier**	**Start Date**	**Period on Project (months)**	**% of Full Time**	**Scale**	**Increment Date**	**Basic Starting Salary**	**London Allowance (£)**	**Super-annuation and NI (£)**	**Total cost on grant (£)**
Researcher	Dr TL Mullett	03/04/2016	36	100	FA6 sp31	01/10/2016	32277	0	7373	127688
Researcher	Research Assistant (0.25 FTE)	03/04/2016	36	25	FA4 sp18	01/10/2017	22029	0	4747	21034
									Total	148722

Applicants

Role	Name	Post will outlast project (Y/N)	Contracted working week as a % of full time work	Total number of hours to be **charged** to the grant over the duration of the grant	Average number of hours per week **charged** to the grant	Rate of Salary pool/banding	Cost estimate
Principal Investigator	Professor Neil Stewart	Y	100	1485	11.2	110232.22	99209
Co-Investigator	Professor Chris Starmer	Y	100	495	3.8	136200	40860
						Total	140069

Travel and Subsistence

Destination and purpose		Total £
Outside UK	International Conference travel - PI and PDRA US (x2) and Europe conferences (x1)	9500
Within UK	Project Meeting Travel to London (2 people, x6 per year, 3 years)	3600
Outside UK	PDRA exchange to US 3 months	6000
Within UK	US PDRA exchange to UK	6000
	Total £	25100

Other Directly Incurred Costs

Description	Total £
Participant payments for eye tracking experiments	15000
Impact activity (field trials with end users)	8000
RA recruitment costs	2000
High Performance Project Computer	2000
INTERNATIONAL - 1 year Research Assistant based at Caltech	45000
Total £	72000

Other Directly Allocated Costs

Description	Total £
Pool staff costs	11572
Total £	11572

Timetable estimates of the number of months after the start of the project to reach the following stages:

Stage	Number of Months
Completion of all preparation and design work	30
Commencement of fieldwork or material/information/data collection phase of study	0
Completion of fieldwork or collection phase of study	0
Commencement of analysis phase of study (substantive phase where research facilities are involved)	1
Completion of analysis phase of study	36
Commencement of writing-up of the research	12
Completion of preparation of any new datasets for archiving	36
Completion of writing-up	36

Data Collection

If the research involves data collection or acquisition, please indicate how existing datasets have been reviewed and state why currently available datasets are inadequate for this proposed research. If you do not state to the contrary, it will be assumed that you (as principal applicant) are willing for your contact details to be shared with the affiliated data support service (UK Data Service) working with the Research Councils.	There are a number of existing datasets from projects using eye-tracking to measure attention during choice and deliberation. Although these are varied, none use tasks complex enough to address the empirical questions we wish to answer. See Data Management Plan.
Will the research proposed in this application produce new datasets?	Yes
Will this data be:	✔ Quantitative Qualitative

Please give a brief description of the datasets.	We envisage creating records of eye movements and choices made during laboratory choices. See Data Management Plan.
It is a requirement to offer data for archiving. Please include a statement on data sharing. If you believe that further data sharing is not possible, please present your argument here justifying your case.	We will share the data using the UK Data Service, our web pages, and journal web pages.
Who are likely to be the users (academic or non-academic) of the dataset(s)?	Users of the laboratory data will be other academics in Psychology, Neuroeconomics, and Marketing. Field data will be shared with regulators.
Please outline costs of preparing and documenting the data for archiving to the standards required by the affiliated data support service (UK Data Service) working with the Research Councils.	We have costed the preparation and documentation of datasets into PDRA time.

OTHER INFORMATION

Academic Reviewers

1	Name	Organisation	Division or Department	Email Address
Dr Christopher Summerfield		University of Oxford	Experimental Psychology	christopher.summerfield@psy.ox.ac.uk

Classification of Proposal

(a) User Involvement

The nature of any user engagement should be indicated

Design	x
Execution	x
Dissemination	x
Training	
Not applicable	

Proposal Classifications

Research Area:

Research Areas are the subject areas in which the programme of study may fall and you should select at least one of these. Once you have selected the relevant Research Area(s), please ensure that you set one as primary. To add or remove Research Areas use the relevant link below. To set a primary area, click in the corresponding checkbox and then the Set Primary Area button that will appear.

Please select one or more Research Areas

Subject	Topic	Keyword
Animal science	Psychology	Decision making (humans)
Animal science	Psychology	
Animal science	Psychology	Consumer behaviour
Animal science	Psychology	Behaviour
Animal science	Psychology	Cognition
Management and business studies	Marketing	
Management and business studies	Marketing	Consumer Behaviour and Psychology
Psychology	Cognitive Psychology	Decision Making
Psychology	Cognitive Psychology	
Psychology	Cognitive Psychology	Eye movement
Psychology	Experimental Psychology	
Psychology	Experimental Psychology	Eye movements
Psychology	Psychology (General) [Primary]	
Psychology	Psychology (General) [Primary]	Cognition
Psychology	Psychology (General) [Primary]	Consumer behaviour
Psychology	Psychology (General) [Primary]	Decision making (humans)

Qualifier:

Qualifiers are terms that further describe the area of study and cover aspects such as approach and geographical focus. Please ensure you complete this section if relevant.

To add or remove Qualifiers use the links below.

Free-text Keywords:

Free-text keywords may be used to describe the programme of study in more detail. To add a keyword, you first need to search existing Research Areas by entering the keyword in the Search box and selecting the Filter button.

If the keyword is adequately reflected by one of the terms displayed below, click in the corresponding checkbox then select Save. If no potential matches are displayed, or none of those displayed are suitable, select the Add New button followed by the Save button to add it as a descriptor.

To add or remove those previously added use the links below.

Pathways to Impact

We will target those in industry and public policy with interest in economic decision making. While the focus of this programme is on informing micro-level theory of economic choice, we will develop the implications for regulation and for the competitiveness of UK financial industry. Our strategy will be to translate the laboratory work detailed in the Case for Support into the field with a series of randomised control trials, detailed below. To deliver significant impact it is essential for us to bridge the divide from the laboratory by working on live problems for the regulator and industry using real consumers making real decisions.

Since their inception in 2012 the Financial Conduct Authority (the UK regulator for all financial products, like savings accounts, pensions, mortgages, credit cards, and insurance) have placed significant emphasis on behavioural regulation. This includes "...getting a better understanding of why consumers act in the way they do, so we can adapt our regulation to their [consumers'] common behavioural traits" (Martin Wheatley, outgoing Chief Executive, FCA). Indeed, the first publication from the FCA made the case for using behavioural economics in regulation (Erta, Hunt, Iscenko, Brambley, 2013). Recently Stewart has worked closely with the new Behavioural Economics and Data Science Team at the FCA, led by Dr Stefan Hunt, on the psychology of structured deposits (Hunt, Stewart, & Zaliauskas, 2015). The FCA are at the beginning of a project on the complexity of financial products. The pathway to impact within the FCA will be via regular meetings between members of the FCA Behavioural and Data Science Team, and Stewart and Mullett (most recently in August 2015). Ultimately, as the data will drive public policy change regarding presentation and advertising of financial products, with the creation of regulations grounded in behavioural science. The outcome of this engagement will be the design of randomised control trials in collaboration with the FCA and a customer-facing financial services provider using real consumers making real decisions. Dissemination via the FCA working paper series will have more significant reach than academic publication alone. Please see the letter of support from the Financial Conduct Authority.

Warwick has a formal collaboration with the consumer group Which?, and Stewart has worked closely with Alex Chesterfield, Head of Behavioural Insights, and team members Sam Himmelweit, Harriet Patterson, and Phillida Cheetham. The formal collaboration covers data sharing, exploitation, and publication rights, etc., and we have several existing and completed projects (e.g., on credit card repayment behaviour and expectant mums' birth choices). Early insights from this work will feed into Which?'s project on the complexity of financial products. They key route will be the monthly joint meetings between Warwick and Which? Please see the letter of support from Which? Again, we would seek to implement insight from these grants in a practical financial decision domain as part of Which?'s consumer testing programme, and thus we will identify a practical application of the drift diffusion model to a consumer choice of value to which and implement a field trial. Likely candidates are: (a) the development of product information sheets for mortgages, savings accounts, pensions, etc., within the context of providing behavioural nudges, and (b) information provision for telecoms choices.

The UK Cards Association is the industry body for all credit card providers in the UK. Stewart (and Gathergood, Economist, Nottingham) have a significant existing collaboration, with the sharing of millions of credit card statements between about 10 of the largest card companies and Warwick and Nottingham Universities. Contacts are Paul McCarron, Head of Cards and Fraud Control, and Richard Koch, Head of Policy. Stewart contributed evidence to the 2009 White Paper reviewing of the credit industry. Of key interest is (a) consumers'

decisions around credit card repayments, and their integration of information from monthly statements and (b) consumers choice of card during switching and how cards are evaluated. The former fits well with the evaluation work; the latter fits well with the choice work. Dissemination of research findings will be via presentation to the Current Affairs working group, with representatives from every UK card provider.

We will also work closely with the Economic and Social Research Institute, an independent research institute funded mainly by the Irish Government. Our key contact is Dr Peter Lunn, who has expertise in the application of decision making and consumer psychology research to policy and regulation.

These routes to impact are time consuming. They would be led by the PI, with significant involvement from the CI to distribute the load. We anticipate that 15% (i.e., half) of PI time will be spent pursuing impact. These contacts will also add value for the PDRA and CI as they can be taken to build research collaborations beyond the grant, independently of the PI. We have requested funding to develop the field trials over the course of the grant, and in previous experience the ability to make modest commitment to a larger programme of randomised control trials enhances engagement.

Beyond these three existing routes to impact, during the course of the grant we will seek to extend our contacts and influence to (a) one major UK supermarket, (b) one major UK insurance company, and (c) one major bank.

Table 1. Translational field studies.

Translational Field Study	Anticipated Design
1. Financial Conduct Authority	A representative sample of 2,000 investors in structured deposits, payday loans, or other complicated financial products.
2. Which?	Presenting multi-attribute choice options to 2,000 consumers switching broadband and or expectant mums.
3. UK Cards	A representative sample of 2,000 cardholders making (a) direct debit setup decisions or (b) monthly repayment decisions.

Finally, the opportunity to work with real consumers making real decisions with non-trivial economic consequences (maybe tens of pounds with broadband, hundreds of pounds with credit cards, and thousands of pounds with structured deposits of mortgages, and hours of pain with expectant mums) is of significant academic value. The issue of incentivized choice is critical in Experimental Economics (though less so in Psychology), and this impact work extends the lab work into high stakes choice.

Pathways to Impact

Accumulating to choose, but accumulating what? Drift diffusion modelling of economic preference

The drift diffusion model (Ratcliff, 1978) is the leading model of the choice process in neuroeconomics (Krajbich, Armel, & Rangel, 2010). Choice is modelled as an accumulation of a series of microsamples of evidence to threshold. Figure 1 shows the difference in evidence accumulated for a choice between an apple and a chocolate bar. For example some microsamples about the sweetness of the chocolate lead to a steps towards the chocolate, but the next microsamples about the crunchiness of the apple leads to a step towards choosing the apple. But what, exactly, is the evidence that is accumulated? This is currently unknown.

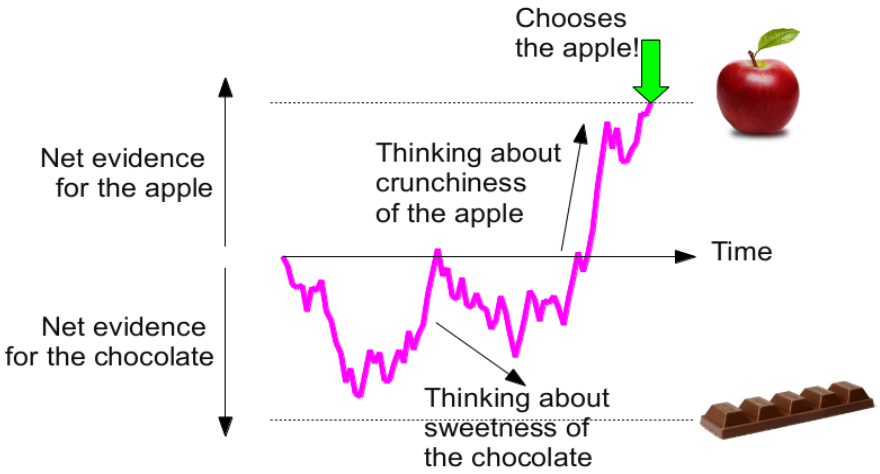

Figure 1. The attentional drift diffusion model.

Much of the existing work has focussed based upon the assumption that an individual is biased towards accumulating evidence based upon the specific piece of information currently attended (Fisher & Rangel, 2015; Krajbich et al., 2010). In the model's terms, we say that the *drift rate* depends on attention. For example, whilst an individual directs their attention towards a chocolate bar they would accumulate evidence based upon its taste and sweetness. In the model's terms, we say they are drifting towards choosing the chocolate. When attention is instead directed towards an apple evidence would be accumulated based upon its crunchiness or healthiness. In the model's terms, we say they are drifting towards choosing the apple.

Early work in this area has almost exclusively used choices between simple items. These include choices between snack foods (Krajbich & Rangel, 2011) and attractive faces (Shimojo, Simion, Shimojo, & Scheier, 2003; Bird, Lauwereyns, & Crawford, 2012). These studies have found many reliable phenomena supporting the hypothesis that accumulation is biased by attention. The most fundamental evidence is that an item is more likely to be preferred when it is viewed for longer. This is true when subjects look freely at whichever items they so choose and when they are forced to attend to one item more, showing attention can cause changes in preference. Furthermore, when choosing which unpleasant foodstuff or poster they most want to avoid, they are more likely to reject the item presented for longer (Armel, Beaumel, & Rangel, 2008).

Further support for evidence being accumulated for the attended alternative is the gaze cascade or gaze bias effect (Shimojo et al., 2003; Glaholt et al., 2009; Bird et al., 2012). In

Case For Support

the moments immediately prior to choice, individuals become increasingly more likely to look at the subsequently chosen item. If evidence is more rapidly accumulated for an item whilst it is attended then it is more likely to cross the threshold and be chosen whilst attended.

Viewing time and gaze bias effects described above are well replicated. But, to date, choice items have been either one dimensional or have all of their attributes presented in a single area of the screen (e.g. images of food). In these tasks it is only possible to measure what item is attended, not the attribute or information currently being considered. This is a significant issue, and one which is crucial to understanding the impact of complex products, styles of information presentation and marketing, as well as informing scientific models of choice.

A compounding weakness of the existing evidence is that it is heavily focussed upon testing the existing models of choice. For this reason, in many papers the only tested assumption is that attention increases the weight given to the information. Therefore, it is always assumed that any bias would result from an interaction between attention and stimulus value. The main effect of attention is never tested. However, in the mere exposure effect subjects prefer a more familiar option independent of value (Zajonc, 1968). As we show below, it turns out the effects of attention and value are independent—a challenge to the drift diffusion model.

There is also debate regarding the validity of forcing subjects to attend to each option for defined periods. It seems inevitable that such an extreme and artificial manipulation of the attention and information search process will affect choice. Recently, more advanced methodology has been developed within the domain of psychophysics (Teodorescu & Usher, 2013). Subjects may direct their attention freely to all information, but the properties of the stimuli themselves change over time. By masking these changes from the subjects it is possible to test differing assumptions of evidence accumulation and attention without exogenously disrupting the information search process.

The Challenge to the Drift Diffusion Framework

In our laboratories, we have observed that there is effectively no link between the attention to attributes and the decision outcome. This is a direct challenge to the attentional drift diffusion model, in which the drift rate is assumed to be higher when attending to more favourable attributes. We can only make this claim because, unlike earlier work, we have used spatially separated attributes.

We present three examples from three different scenarios. The first is from a risky choice experiment, in which people choose between a series of lotteries (Stewart, Hermens, & Matthews, 2015). Figure 2A shows the effect of a fixation to an attribute on the probability of choosing the riskier gamble, as estimated from a mixed effects logistic regression of choice on the number of fixations to risk and reward in each gamble. The coefficients shown in Figure 2A are, essentially, estimates of the drift rates attached to attending to each attribute. Fixations to the attributes of the risky gamble increase the probability of a risky pick, whether this is to either the high reward or the low probability. Fixations to either of the attributes of the safe gamble, the low reward or the high probability, increase the probability of a safe pick. This is unsurprising—but what is surprising is the absence of a difference between the effect of looking more at the attribute that makes the gamble good compared to the attribute that makes the gamble bad. For example, for the risky gamble, looking at the high prize should seem like strong evidence for taking the risk, but looking at the low probability of winning should seem like weak evidence for taking a risk, at best, or even evidence for choosing a different gamble. In terms of Figure 2, the two positive coefficients are about the

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same size and the two negative coefficients are about the same size, which means views of the high reward and low probability have equal effects on choice. Table 1 quantifies this effect. The first two rows compare the fits of a model where coefficients are allowed to take free values (as in Figure 1) with a model where the coefficients for the attributes within an alternative are constrained to be equal. The accuracy reduction from 71.6% to 68.7% is small. In sum, which attributes people are look at does not matter—looking more at the positive attributes of an alternative does not make you more likely to choose that alternative than looking more at the negative attributes.

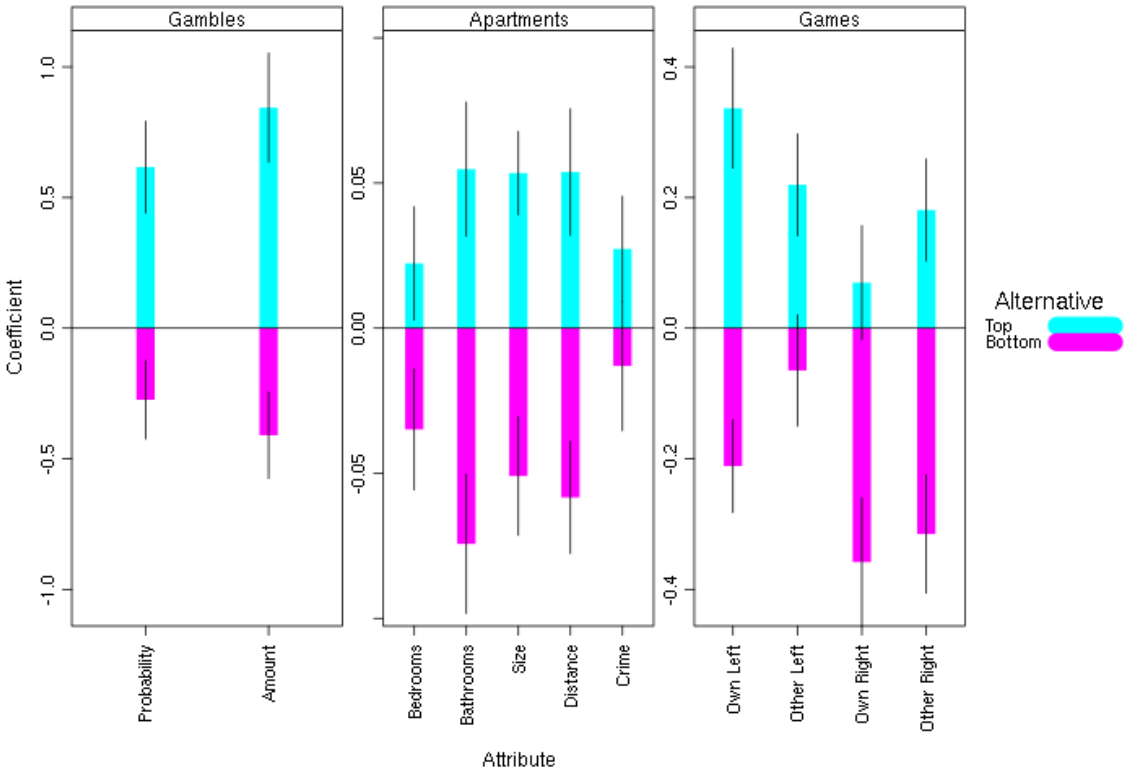

Figure 2. The effect on choice of attribute fixations.

We can also explore the effect that changes in the magnitude of attributes have on the associations between attribute fixations and choice. For example, other things held equal, fixating a prize of £500 should be stronger evidence for choosing that gamble than fixating a prize of £100. The bottom two rows explore the effect on including such magnitude by fixation interactions in the mixed effects logistic regression. To the nearest 0.1%, there is no change in accuracy when the interactions are included.

This pattern is robust. Our second study is of multi attribute choices in which participants chose between apartments with different numbers of bathrooms and bedrooms, different sizes, and different distances to the city centre, and different crime rates (Mullett & Tunney, 2015). Our third example is strategic choices where attributes are payoffs for you and your opponent determined by your choice of top vs bottom and their choice of left vs right. We included classic economic games prisoner's dilemma, stag hunt, and hawk dove (Stewart, Gächter, Noguchi, & Mullett, 2015). Our second and third studies show the same pattern. Looking at the worst aspects of an alternative is just as predictive of choosing that alternative as looking at the best aspects. Making this assumption in the modelling reduces accuracy by 2.9% for apartment choices and 0.4% for games. For apartments this is especially surprising

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as crime rates and large distances from the city centre are reasons against choosing the alternative. And there is no interaction between the value of an attribute and the number of views. Including such interactions has no effect on accuracy for apartments and only increases by 0.8% for games.

Table 1. *Modelling of Gambles, Apartments, and Games Choices*

	Gambles		Apartments		Games	
Model	Accuracy	BIC	Accuracy	BIC	Accuracy	BIC
Fixations Only						
Free Coefficients	71.6%	3,882	67.4%	4,011	67.3%	4,285
Equal Coefficients	68.7%	4,164	64.5%	3,993	66.9%	4,319
Fixations and Magnitudes						
No Interactions	77.9%	3,327	85.5%	2,289	81.7%	2,855
With Interactions	77.9%	3,335	85.5%	2,368	82.5%	2,797

Note. *Smaller BIC indicates better fit, penalised for complexity*

What then is the implication for the attentional drift diffusion model? Critically, the link between attention and the drift diffusion rate is broken at the attribute level. This is puzzling —taken literally, this would mean that when choosing between two shopping baskets of goods, looking more at one basket will be associated with choosing that basket, but looking more at the higher value items rather than the lower value items within one basket will have no effect. How might this be reconciled within the attentional drift diffusion model?

The Research Programme

Series 1: Replication and Unification

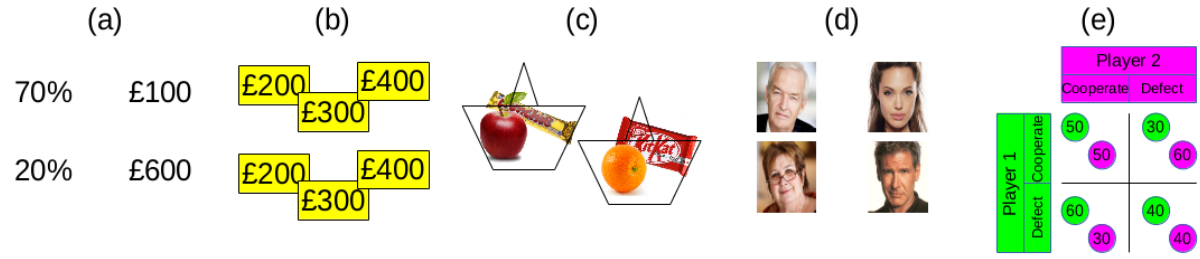

Figure 3. Five different types of stimuli.

Our pilot work has shown that the link between attention and drift rates does not hold at the attribute level. The experiments in Series 1 will replicate these findings across five different stimuli types within the same experiment. All stimuli contain spatially separate attributes, to allow us to estimate drift rates at the attribute level. Figure 3 illustrates (a) choices between gambles described as probability and amounts where attributes should be multiplicatively integrated, (b) choices between gambles presented as bags of equally likely tickets, where attributes stand alone and can be integrated additively, and (c) choices between baskets of goods, after Krajbich et al. (2010) and Reutskaja, Nagel, Camerer, and Rangel (2011) which are more affectively more rich than monetary sums, (d) choices between arrays of faces, after Glaholt and Reingold (2009), for which there is an immediate affective value in looking longer at nicer faces, and (e) choices in social games like prisoner's dilemma (after Stewart et al. 2015, Wang, Spezio, & Camerer, 2010). By using the same design across this range of stimuli, we will establish the generality of the attribute-level drift rate link, or provide

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important boundary conditions. Drift rates will be estimated from mixed-effects logistic regressions and from fitting the attentional drift diffusion model.

Series 2: The Causal Link Between Gaze and Choice
Causal inferences about the link between eye movements and choice require experimentally manipulating gaze. This has been successful for whole objects (Shimojo et al., 2003).

2A. We will use choices between bags of lottery tickets (Figure 3b). The critical manipulation will be to change the value of one of the tickets between a first and second fixation. By synchronising the switch to occur during a saccade, the change will not be detected. Different accumulator models predict different effects of this manipulation, and in particular it matters whether stopping is based on hitting an absolute threshold for one accumulator or whether it is the difference in accumulators (as in the drift diffusion model, Figure 1). It also matters whether there is a gaze-cascade causal link so that attention is allocated based on evidence accumulated.

2B. By hiding or revealing a ticket part way through a choice, we can examine the relationship between visual fixations and working memory. If visual fixations are used as an alternative to memory retrieval then the effect on choice will be very large. If visual attention is merely a proxy for the item or attribute currently being considered then the effect will be negligible. Furthermore, if accumulation is based only upon attention to items, then hiding an attribute should have little effect on accumulation.

Series 3: The Pretty, the Good, the Bad, and the Ugly
In Series 3 we will address how negative information is integrated into the drift rate. The majority of prior work has used only pleasant items, such as headshots of models or financial gains. It is unknown whether accumulation rates can in fact turn negative and the alternative hypotheses have not been robustly tested using visual attention.

3A. By showing choices between bundles of pleasant poster images (such as rural landscapes) or unpleasant poster images (such as crying children or rubbish dumps), we can examine how negative information is integrated into the choice process. We will use three-way choices and an accumulator model. Accumulator models generalise the drift diffusion model by maintaining separate accumulators for the evidence for each alternative. We can examine whether attending to a negative outcome results in the accumulation rate turning negative for the attended item, or if positive evidence is instead accumulated for all the alternatives. By contrasting select-the-best and select-the-worst choices we can examine whether evidence is always accumulated based upon the intrinsic positive value of an item, or based upon the type of evidence specific to the current question. In addition, we can see whether attention becomes biased towards the best or worst picture in a bundle depending upon choice condition. This comparison of top-down and bottom-up control of deliberation informs the modelling and real-world nudges and marketing.

3B. We will contrast stimuli with a visual affective value (e.g., pleasant or unpleasant images) with stimuli without a visual affective value (e.g., monetary sums). A financial loss is an unpleasant outcome, but the number “-10” is not inherently unpleasant to look at in the same way a disgusting stimulus is. We will repeat the design from 3A with financial gambles and economic games. By comparing the 3A and B we can isolate visual and semantic effects.

Series 4: Object-level vs Choice-level drift rates
In Series 4 we will compare choices between pairs of single objects with choices between pairs of objects bundles (Figure 3C). The central question is, how are drift rates estimated

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from choices between two objects related to drift rates estimated from choices between bundles of objects? Drift rates could be formed at the level of objects, with different drift rates for the apples and oranges in the same basket, or at the higher level of the basket, with a common drift rate for fixating any fruit. Participants will be recorded making both kinds of choices. Across experiments, we will vary the stimulus type, including choices between supermarket goods, images like faces, and two- and four-ticket lotteries. It will then be possible to estimate the drift rate in binary choices between two items. This can be used to examine whether the drift rate measured in the basket choices is an average of the drift rates for the items within it, or the drift rate of the attended item only.

Series 5: Drift Rate Construction

How is the object-level drift rate built? On an initial fixation, before other attributes are visited, the drift rate can only be (a) a prior, fixed drift rate or (b) based solely on that attribute magnitude. The drift rate on later fixations cannot be based only on the current attribute—otherwise we would have seen differential drift rates across attributes above—and so they must be based on some alternative-level drift rate. Essentially, one must be constructing an object-level drift rate as you explore the attributes. Measuring this learning process requires alternatives with at least three or more attributes, so that the learning process is spread over many fixations. Eye movements will be recorded during choices between baskets of food items and between multi-attribute items such as apartments. Modelling will involve including an interaction with fixation ordering, so that the attribute magnitude by fixation count interaction absent on aggregate can differ between early and late fixations. We should see differential drift rates for attributes converge onto a single alternative level drift rate. Finally, we will include choices between bundles of monetary amounts framed as gambles against nature or as economic games against another person to explore top down effects on the interpretation of attributes in drift rate construction.

Series 6: Drift Rate Relativity

Using three or more alternatives in a choice also allows us to investigate the relativity of drift rates. Non-human primate neurons respond according to the difference between the current reward value and the average value of all alternatives (Padoa-Schioppa, 2009; Tremblay & Schultz, 1999) and to social comparisons of their reward to that of others (e.g., Barraclough, Conroy, & Lee, 2004; Hopper, Lambeth, Schapiro, & Brosnan, 2014; see Price & Brosnan, 2012, for a review). Human neuroimaging shows that activity in the orbito-frontal cortex represents the value of an outcome compared to the foregone option (Elliot, Agnew, & Deakin, 2008) or the currently attended option compared to the unattended alternative (Lim, O'Doherty, & Rangel, 2011). Participants will make choices involving multiple options. By having multiple good/poor alternatives and by varying the average value of all items available, different relativistic assumptions will make different predictions. We will use gambles, consumer choices, and economic games. This will build upon existing work examining whether relativity is based upon the average of all alternatives (Knutson, Taylor, Kaufman, Peterson, & Glover, 2005), difference to the next best (Krajbich & Rangel, 2011), rank order (Mullett & Tunney, 2013), or a social comparison (Maccheroni, Marinacci, & Rustichini, 2012).

Together the six experiment series will inform the development of a model of drift rates in choice, including (a) how drift rates vary across choice materials, contrasting materials with and without intrinsic affective value, (b) drift rates for positive and negative value stimuli, (c) the causal link between gaze and choice, and (d) the construction of drift rates over the time course of a decision, over attributes, and across choice alternatives.

Case For Support

Justification of Resources

Staff, Directly Incurred Posts
PDRA Mullett. We request 100% support for PDRA Mullett. A postdoctoral appointment is essential here, as the level of technical skill required to run and analyse eye movement data is high. As outlined in *Staff Duties*, Mullett will design the studies with the PI and lead on the writing of the majority. Mullett will program the eye movement system and implement the statistical analysis designed with the PI using the R and Matlab programming languages. Mullett will also take a secondary role in the impact programme, and lead on the supermarket collaboration.

PDRA at Caltech. We seek 100% support for a 1-year PDRA at Caltech. The experimental games eye tracking from Series 1, 3, 5, and 6 will be conducted at Caltech, together with a subset of cross-lab replications.

RA. We request 25% support for an RA. BSc or MSc level training in Psychology or Behavioural Science will be sufficient. As outlined in *Staff Duties*, testing of participants one-by-one, and testing 100 people is about 3 weeks of full time work. RA support will free PDRA time for the more skilled writing and analysis.

Staff, Directly Allocated Posts
PI Stewart. We request 30% support for Stewart. 15%, half of this support, will be spent on the laboratory programme, designing experiments and analysing data with the PDRA. Stewart has developed a new statistical analysis for eye movement data (see two papers forthcoming in *Journal of Behavioural Decision Making*) and this work will continue here. The other 15% is required for the ambitious impact work, which requires professorial level and extensive liaison with the three current industry partners to negotiate access to data and field trials, to set up access to three new partners, and to disseminate results back into industry.

CI Chris Starmer. We will seek 10% support for significant input from Experimental Economist Prof. Starmer. Because of the interdisciplinary nature of the research, this contribution is important for maximising the academic impact of the work beyond Psychology.

CI Colin Camerer. We do not seek support for Behavioural Economist Prof. Camerer's 10% contribution in the Caltech PDRA year.

Other Directly Incurred Costs
Participant payments. We request £15,000 for laboratory experiments (see Table). We have costed these using the lab flat rate of £10 per hour (or US$ equivalent). The round number of 100 participants is based on estimation of confidence intervals from our pilot work.

Computer resources. The computations required to estimate drift diffusion models and assess model flexibility (e.g., with parameter space partitioning, Mullett & Stewart, 2015; Pitt, Woojae, Navarro, & Myung, 2006) require serial search of model parameter spaces. Compared to typical regressions which take fractions of a second, these methods take of the order of days or weeks on, for example, a typical Intel 8-core i7-4770 CPU. We request £2,000 for this dedicated computer machine.

Justification for Resources

Series	Purpose	Design and Cost
1. Replication and Unification	To estimate the attribute-level-drift-rate link across the range of stimuli used in the literature.	Two experiments, each with five within-participant stimulus conditions. N=100 per experiment. 2 x 100 x £10 = £2,000
2. Causal Link	Experimentally manipulating attributes and gaze estimates the causal link between attribute-level gaze and choice	Two experiments, with within-participant manipulation. N=100 per experiment. 2 x 100 x £10 = £2,000
3. Pretty, Good, Bad, Ugly	Extension to negative valence stimuli	Two experiments, with within-participant manipulation. N=100 per experiment. 2 x 100 x £10 = £2,000
4. Object- vs. Choice-level Drift Rates	Are drift rates estimated from single objects generalisable to bundles?	Three experiments, varying stimuli. N=100 per experiment. 3 x 100 x £10 = £3,000
5. Drift Rate Construction	Exploring drift rates over the time course of a choice as attributes are acquired	Three experiments, varying stimuli. N=100 per experiment. 3 x 100 x £10 = £3,000
6. Drift Rate Relativity	Are drift rates	Four experiments, varying stimuli. N=100 per experiment. 4 x 100 x £10 = £4,000

Pooled Technician
Lab manager. We request 10% technician time to maintain and develop the eye tracking equipment and run the laboratory and participant panel.

Impact
We seek £8,000 to cover some of the costs of the impact work. Other costs will be met by the partners, though the exact contribution depends of the details of the design developed after the results of laboratory experiments are known.

Partner	Cost
Financial Conduct Authority	Addition of four questions to market research panel run by YouGov. 2,000 people. £4,000
Which?	Piloting of product information sheets in a RCT on Prolific Academic / MTurk, £2,000
UK Cards Association	Piloting of RCTs on repayment decisions and direct debit signups on Prolific Academic / MTurk, £2,000

Travel and Subsistence
We seek the costs of day visits to impact partners, all London based. We anticipate 6 visits per year x 2 people x 3 years. We will attend the SJDM conferences in 2016 and 2017. 2 people x 2 years (Vancouver and New Orleans) and the SPUDM conference (European city) in 2017. These conferences are the most significant in the domain, giving coverage of America and Europe. We seek the cost of a postdoc exchange with Prof. Colin Camerer at Caltech. Caltech is the home of Camerer and Rangel labs, leaders in eye tracking economics.

Justification for Resources

NEIL STEWART

E-mail neil.stewart@warwick.ac.uk

WWW www.stewart.warwick.ac.uk [for ResearcherID, Google Scholar, ORCID]

Education

10.97-06.01 PhD Psychology, Perceptual Categorisation, Warwick

10.94-06.97 BA Hons 2.1 Natural Sciences, Experimental Psychology, Cambridge,

Employment

10.09- Professor of Psychology, Warwick

08.06-09.09 Reader in Psychology, Warwick

01.03-07.06 Lecturer in Psychology, Warwick

07.01-12.02 Postdoctoral Research Fellow, Warwick

10.97-06.01 Graduate Teaching Assistant, Warwick

Selected Recent Publications

Hunt, S., Stewart, N., & Zaliauskas, R. (2015). Two plus two makes five? Survey evidence that investors overvalue structured deposits. *Financial Conduct Authority Occasional Papers in Financial Regulation, 9.* http://www.fca.org.uk/your-fca/documents/occasional-papers/occasional-paper-9

Stewart, N., Gächter, S., Noguchi, T., & Mullett, T. L. (in press). Eye movements in strategic choice. *Journal of Behavioral Decision Making*.

Stewart, N., Hermens, F., & Matthews, W. J. (2015). Eye movements in risky choice. *Journal of Behavioral Decision Making*. doi: 10.1002/bdm.1854

Stewart, N., Reimers, S., & Harris, A. J. L. (2015). On the origin of utility, weighting, and discounting functions: How they get their shapes and how to change their shapes. *Management Science, 61,* 687-705. doi: 10.1287/mnsc.2013.1853

Walasek, L., & Stewart, N. (2015). How to make loss aversion disappear and reverse: Tests of the decision by sampling origin of loss aversion. *Journal of Experimental Psychology: General, 144,* 7-11. doi: 10.1037/xge0000039

Noguchi, T., & Stewart, N. (2014). In the attraction, compromise, and similarity effects, alternatives are repeatedly compared in pairs on single dimensions. *Cognition, 132,* 44-56. doi: 10.1016/j.cognition.2014.03.006

Noguchi, T., Stewart, N., Olivola, C. Y., Moat, H. S., & Preis, T. (2014). Characterizing the time-perspective of nations with search engine query data. *PLoS ONE, 9,* e95209. doi: 10.1371/journal.pone.0095209

Navarro-Martinez, D., Salisbury, L. C., Lemon, K. N., Stewart, N., Matthews, W. J., & Harris, A. J. L. (2011). Minimum required payment and supplemental information disclosure effects on consumer debt repayment decisions. *Journal of Marketing Research, 48,* S60-S77. doi: 10.1509/jmkr.48.SPL.S60

Ungemach, C., Stewart, N., & Reimers, S. (2011). How incidental values from our environment affect decisions about money, risk, and delay. *Psychological Science, 22,* 253-260. doi: 10.1177/0956797610396225

Vlaev, I., Chater, N., Stewart, N., & Brown, G. D. A. (2011). Does the brain calculate value? *Trends in Cognitive Sciences, 15,* 546-554. doi: 10.1016/j.tics.2011.09.008

Awards

2008 Experimental Psychology Society Prize Lecturer.

Society for Judgment and Decision Making's Hillel Einhorn New Investigator Award 2006.

American Psychological Association Division of Experimental Psychology 2005 Young Investigator Award in Journal of Experimental Psychology: Learning, Memory, and Cognition.

Funded Grant Proposals

Sanborn, A., & Stewart, N. (10.13-09.16). Combination rules in information integration. ESRC ES/K004948/1. fEC £348,802.

Starmer, C., Gaechter, S., Barr, A., Gathergood, J., Sefton, M., Cubitt, R., Aickelin, U., Turocy, T., Fatas, E., Zizzio, D. J., Hargreaves-Heap, S., Sugden, R., Poulsen, A., Brown, G. D. A., Stewart, N., Mackay, R., Chater, N., Read, D., & Loomes, G.(01.13-12.16). Network for integrated behavioural science. ESRC ES/K002201/1. fEC £3,923,914.

Loomes, G., Brown, G. D. A., Read, D., Stewart, N., & Chater, N. (01.13-12.16). Risk,time and society: The behavioural economics of value. Leverhulme. £902,875.

Stewart, N. (04.09-03.10). *The psychology of credit card repayments.* ESRC. fEC £98,987.

Stewart, N. (01.08-12.10). *A decision-by-sampling account of decision under risk.* ESRC. fEC £248,899.

Adelman, J., Kent, C., & Stewart, N. (09.07-08.08). *Information and time in absolute identification.* ESRC. fEC £101,345.

Stewart, N. (04.06-03.09). *Why unidimensional identification is so poor: Modelling a core cognitive limit.* ESRC. £164,407.

Stewart, N. (01.05-11.05). *Financial decision tools.* ESRC. £45,427.

Chater, N, Hodges, S., Nudd, G. R., & Stewart, N. (03.02-02.04). *The cognitive science of financial e-advice.* ESRC. £262,000.

Brown, G. D. A., Chater, N., Lamberts, K, & Stewart, N. (07.01-06.04). *A new unifying model of memory, identification, and categorisation.* ESRC. £133,000.

Colin F. Camerer

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Education

University of Chicago, Graduate School of Business. MBA, 1979 (finance)
University of Chicago, Graduate School of Business. Ph.D., 1981 (behavioral decision theory)
Johns Hopkins University. BA, 1977 (quantitative studies)

Posts

2008-	Robert Kirby Professor of Behavioral Finance and Economics, California Institute of Technology
1994-2007	Rea A. and Lela G. Axline Professor of Business Economics, California Institute of Technology
1991-1994	Professor of Strategy and Behavioral Science, University of Chicago, Graduate School of Business
1997-1998	Visiting Fellow, Center for Advanced Study in Behavioral Sciences, Stanford University
1991-1992	Visiting Scholar, Russell Sage Foundation
1989-1991	Associate Professor of Decision Sciences, The Wharton School, University of Pennsylvania
1983-1989	Assistant Professor of Decision Sciences, The Wharton School, University of Pennsylvania
1981-1983	Assistant Professor of Policy and Environment, Kellogg Graduate School of Management, Northwestern University

Selected Publications from 2010 (see web page for full listing)

De Martino, Benedetto, John P. O'Doherty, Debajyoti Ray, Peter Bossaerts, and Colin Camerer. " In the mind of the market: theory of mind biases value computation during financial bubbles". Neuron, in press.

Brocas, Isabelle, Juan Carrillo, Stephanie Wang and Colin F. Camerer. "Using eyetracking to understand choices in zero-sum private information betting games" Review of Economic Studies, in press.

Camerer, Colin F. "Goals, methods and progress in neuroeconomics" Annual Review of Economics, 2013, in press.

Frydman, Cary, Nicholas Barberis, Colin Camerer, Peter Bossaerts, Antonio Rangel. "Using neural data to test a theory of investor behavior: An application to realization utility." J Finance, in press.

Sonneman, Ulrich, Craig Fox, Colin F. Camerer, Thomas Langer "How psychological framing affects economic market prices in the lab and field" PNAS, in press.

Smith, Alec, B. Doug Bernheim, Colin F. Camerer, Antonio Rangel. "Neural activity reveals preferences without choices" final revision, AEJ: Microeconomics.

Camerer, Colin F. "Experimental, cultural and neural evidence of deliberate prosociality." Trends in Cognitive Sciences. Published online 13 February 2013.

Brown, Alex, Dan Lovallo and Colin F. Camerer "Estimating Structural Models of Equilibrium and Cognitive Hierarchy Thinking in the Field: The case of withheld movie critic reviews", Management Science (online September 4, 2012, doi: 10.1287/mnsc.1120.1563)

Soltani, Alireza, Benedetteo de Martino, and Colin F. Camerer "A range-normalization model of context-dependent choice" PLoS Computational Biology (online), 8 (7): e1002607, 2012.

Wu, Daw-An, Stephanie Wang, Shin Shimojo, and Colin F. Camerer. "Shared attention reduces visual hindsight bias" Psychological Science, 23(12): 1524-33, 2012.

Bhatt, Meghana; Terry Lohrenz; Colin Camerer; Read Montague. "Distinct contributions of the amygdala and parahippocampal gyrus to suspicion and strategic uncertainty in a repeated bargaining game" PNAS, May 29 2012, 109(22): 8728-8733.

Krajbich, Ian; Dingchao Lu, Colin Camerer, Antonio Rangel.. "The attentional drift-diffusion model extends

to simple purchasing". Frontiers in Psychology 3:193, 2012.
Yamada, M., Takahashi, H., Camerer, C. F., Kato, M. Fujie, S., Ito H., Suhara, T. "Neural circuits in the brain that are activated when mitigating criminal sentences." Nature Communications 27 Mar 2012, 1-6.
Izuma, Keise, Kenji Masumoto, Colin F. Camerer, Ralph Adolphs. "Insensitivity to social reputation in autism" PNAS 2011, 108 (42) 17302-17307.
Brunner, Christoph, Colin F. Camerer and Jacob Goeree. "Stationary Concepts for Experimental 2 x 2 Games: Comment" American Economic Review, 2011, 101(2): 1029-40.
Alison Harris, Colin F. Camerer, Ralph Adolphs, Antonio Rangel. "Dynamic construction of stimulus values in the ventromedial prefrontal cortex." PLoS One 2011, 6(6): e21074.
Reutskaja, Elena, Johannes Puls-Konnenberg, Rosemarie Nagel, Colin F. Camerer, Antonio Rangel. "Search dynamics in consumer choice under time pressure: An eye-tracking study" American Economic Review 2011, 101: 900-906
Frydman, Cary, Colin F. Camerer, Peter Bossaerts, Antonio Rangel. MAOA-L carriers are better at making optimal financial decisions under risk. Proceedings of Royal Society B 2011, 278(1714): 2053-2059.
Bhatt, Meghana, Terry Lohrenz, Colin F. Camerer and Read Montague. "Neural signatures of strategic types in a two-person bargaining game" PNAS November 2010 107(46): 19720-19725.
Bushong, Ben, Lindsay King, Colin F. Camerer, Antonio Rangel. "Pavlovian processes in consumer choice: The physical presence of a good increases willingness-to-pay". American Economic Review September 2010, 100(4): 1556-1571.
Wang, Joseph, Michael Spezio and Colin F. Camerer. "Pinocchio's pupil: Eye-tracking and pupil dilation in sender-receiver games" American Economic Review 2010, 100(3): 984–1007.
Tanaka, Tomomi, Quang Nguyen and Colin F. Camerer. "Risk and time preferences in Vietnam: Evidence from experiments and household surveys" American Economic Review March 2010, 100(1): 557-571.
Schlicht, Erik J., Shinsuke Shimojo, Colin F. Camerer, Peter Battaglia and Ken Nakayama. "Human wagering behavior depends on opponents' faces" 2010 PLoS ONE 5(7): e11663.
DeMartino, Benedetto, Colin F. Camerer and Ralph Adolphs. "Amygdala damage abolishes loss-aversion" PNAS February 2010, 107(8): 3788-3792.
Tricomi, Elizabeth, Antonio Rangel, Colin F. Camerer and John O'Doherty. "Neural evidence for inequality averse social preferences" Nature 2010, 463(7284): 1089-1091.
Hare, Todd, Colin F. Camerer, Dan Knoepfle, John O'Doherty and Antonio Rangel. "Value computations in VMPFC during charitable decision-making incorporate input from regions involved in social cognition" Journal of Neuroscience 2010, 30: 583-590.

Grants since 2000

NSF SMA 1329195 "IBSS: Links Between Behavior and Attitudes Across Cultures" $1,000,000 (co-PI) 10/1/2013-9/30/2016
"Collaborative Research: Understanding and Predicting Asset Price Bubbles from Brain Activity", $703,056 [original budget], 4/2013-3/2016. (co-PI)
NSF 009584210, "Bayesian Rapid Optimal Adaptive Design (BROAD) for Estimating Economic Preferences" $467,536, 9/1/2012-8/30/15. (PI)
Tamagawa GOCE grant (joint with Tamagawa University, Tokyo; with 7 Co-PIs), 2008-13.
Moore grant, "Reward and decision making" (with 8 Co-PIs), 2006-2012.
Moore grant, "Large-scale infrastructure for economic experimentation" (with 5 Co-PIs), 2006-2013.
NSF, "Neurometric measures of value" (with Antonio Rangel), $670,000, 2009-12.
Trilience Foundation, "Biological basis of human groups", $101,700, 10/1/09-9/30/11.
HFSP RGP0056/2005-c, "Emotion and Strategy in the Brain" (with PI Angela Sirigu, 4 Co-PIs), $900,000, 2005-08.
NSF: "IGERT: Brain, Mind, and Society: An Integrative Training Program in Valuation, Decision-Making Social Exchange." (One of four co-P.I.s.), 9/1/2007-8/30/2012
NSF Human Social Dynamics (HSD), "Neural correlates of strategic IQ" (with Teck Ho, Ralph Adolphs).
NSF Grant No. SES-095779, "Experimental study of organizational culture", $68,585, 4/1/2001-4/1/2003.
NSF Grant No. SES-0078911, "Collaborative research: Sophisticated learning and strategic teaching in repeated games" (with Teck-Hua Ho), $244,580, 8/1/2000-7/31/2003.

Timothy Mullett
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Education and Employment

2013 – Present: University of Warwick

ESRC Funded Research Fellow in the Network for Integrated Behavioural Sciences

2010 – 2013: University of Nottingham

PhD in Psychology

Thesis Title – Experience and Rank Order Effects in Value Judgement and Decision Making

2009 – 2010: University of Nottingham

MSc in Cognitive Neuroscience and Neuroimaging

With Distinction

Dissertation Title – Value representations by rank order in a distributed network of varying context dependency

2006 – 2009: University of Nottingham

BSc in Psychology and Cognitive Neuroscience

First Class Honours

Dissertation Title – The Effects of Global Context and Retention Interval on Recognition Memory and Subjective Reports of Remembering

2008 : University of Nottingham

Research Internship

During my second year I was selected for a competitive funded internship. My responsibilities included designing, conducting and analysing behavioural experiments.

Selected Publications

Mullett, T.L. & Stewart, N., (in press). Implications of Visual Attention Phenomena for Models of Preferential Choice. *Decision*

Stewart, N., Gaechter, S., Noguchi, T., & **Mullett, T.L.** (in press). Eye Movements in Strategic Choice. *Journal of Behavioural Decision Making*

Mullett, T.L., *& Tunney, R.J.,* (under review). Visual Attention and Attribute Weighting in Choice Models

Marsh, L.E., **Mullett, T.L**., Ropar, D., & Hamilton, A.F. (2014). Responses to irrational actions in action observation and mentalising networks of the human brain. *Neuroimage,* 103: 81-90

Mullett, T.L. & Tunney, R.J. (2013). Value representations by rank order in a distributed network of varying context dependency. *Brain and Cognition,* **82**(1): 76-83.

Tunney, R. J., **Mullett, T. L.,** Gardner, A., & Moross, C. (2012). Does the butcher on the bus phenomenon require a dual process explanation? A signal detection analysis. *Frontiers in Psychology, 3*.

Selected Invited Talks and Conference Presentations

Mullett,T.L., & McDonald, R., (2015) Attention and the EQ-5D: Implications for Policy. Department of Health, Analyst Seminar Series

Mullett,T.L., & Stewart, N. (2015). No Link Between Attention and Item Value in the Diffusion Model of Choice. Subjective Probability Utility and Decision Making, Budapest.

Mullett,T.L., & McDonald R. (2015). Visual Attention in Health Judgements. Subjective Probability Utility and Decision Making, Budapest.

Mullett, T.L., & Stewart N. (2014). Implications of Visual Attention Phenomena for Models of Choice. Theoretical and Empirical Aspects of Decision-Making, University of Bristol.

Mullett, T.L (2013). The brain represents value by rank order within a distributed network of varying context dependency. Subjective Probability Utility and Decision Making, Barcelona

Mullett, T.L (2012). Can our brains tell what's a good idea? TEDx - Nottingham

Mullett, T.L & Tunney, R.J. (2011) The value of experience: A double echo fMRI study of value judgement by recent experience. Cognitive Neuroscience Society, San Francisco.

Funding

2013 – Present

ESRC Research Fellowship within the Network for Integrated Behavioural Sciences
I have successfully applied for NIBS internal experiment funding in 4 separate rounds for 5 different projects. I was PI for 3 of these.

2009 – 2013

University of Nottingham PhD Studentship
Fully funded 1+3 studentship.

2011

Brain Travel Grant
Funding for travel to San Francisco to present at Cognitive Neuroscience Society Meeting

2011

University of Nottingham REF enhancement fund
Funding to conduct an fMRI experiment now published in *Brain and Cognition*

Referees

Dr Richard Tunney (PhD Supervisor)
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Professor Neil Stewart
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Department of Psychology
University of Warwick
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CURRICULUM VITAE – CHRIS STARMER

CONTACT

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CURRENT POSITIONS

Founding Director of CeDEx (since 2000)
Professor of Experimental Economics, Nottingham School of Economics (since 2000)
Director of ESRC Network for Integrated Behavioural Science (since 2013)
Deputy Head of School (since 2006)

EDUCATION

BA (first class) Economics, City of Birmingham Polytechnic, 1985
MA (distinction) Economics, University of East Anglia (UEA), 1987
PhD, UEA, 1992

PREVIOUS ACADEMIC POSITIONS

Research Associate, UEA, 1987-89
Lecturer, UEA, 1989-95
Senior Lecturer, UEA, 1995-2000
Visiting Associate Professor, California Institute of Technology, 2000 (spring)

EDITORIAL

Associate Editor, Journal of Economic Psychology (July 2001 – Dec 2006)
Editorial Board, Journal of Economic Methodology (May 2001 -)
Editorial Board, Berkeley Electronic Journal of Economic Analysis & Policy *(*Feb 2002 -)
Guest Editor, Special Issue of Experimental Economics (Published Dec 2005)
Editorial Board, Experimental Economics (Dec 2006 -)
Guest Editor Experimental Economics (2009-2011)

GRANTS

"The Foundations of Rational Choice Theory", Sept. 1990 - Aug. 1992 (ESRC Award no. R000232269; £87,340).
"Testing Contract Theory", Oct. 1992 - March 1995 (ESRC Award no. L 114 25 1023).
"Identifying and Correcting Biases in the Contingent Valuation Method", Oct. 1992 - March 1995 (ESRC Award no. W119 25 1014; £64,160).
"The Consistency or Inconsistency of Preferences Under Risk and Over Time", Oct. 1994 - Sept. 1996 (ESRC Award no. L122251024; £113,450).
"Understanding Inconsistencies in Preference Concerning Risks and Their Implications for Public Decision Making", Oct. 1996 - Sept. 1999. (Award no. L211252505; £143,634).
Summer Institute on Bounded Rationality in Economics and Psychology. Summer 2002/3. (Volkswagen Foundation, Euro 82,000).
"The role of experimental methods in economics". Sept 2002 – August 2005. (Leverhulme Trust, Award Number F/00 204/K £185, 446).
PI- ESRC Centres and Large Grants Competition, "Network for Integrated Behavioural Science", Jan 2013 – Dec 2016 (ESRC Award no. ES/K002201/1, £3.2 million).

RESEARCH INTERESTS AND EXPERTISE

Main research interests: in individual and strategic decision-making: experimental and behavioural economics: methodology of economics. Known particularly for theoretical and experimental research on individual behaviour in relation to risk. Also known for work exploring the role of focal points in coordination behaviour. Collaborated with leading psychologists including Paul Slovic and Daniel Kahneman. Co-author of "Experimental Economics: rethinking the rules" (Princeton University Press, 2010) - a frank appraisal of what experimentation can and cannot contribute to the growth of knowledge in economics. Consultant for various public and private sector organisations.

SELECTED PUBLICATIONS

Focal Points in Pure Coordination Games: An Experimental Investigation (with J. Mehta and R. Sugden), Theory and Decision, 36, 163-85, 1994.

The Nature of Salience: An Experimental Investigation of Pure Coordination Games (with J. Mehta and R. Sugden), The American Economic Review, 84, 658-74, 1994.

Explaining Risky Choices Without Assuming Preferences, Social Choice and Welfare, 13, 201-13, 1996.

Does Part-Whole Bias Exist? - An Experimental Investigation (with I. Bateman, A. Munro, B. Rhodes, R. Sugden), Economic Journal, Conference Volume, 107, 322-31, 1997.

A Test of the Theory of Reference Dependent Preferences (with I. Bateman, A. Munro, B. Rhodes, R. Sugden), The Quarterly Journal of Economics, 112, 479-505, 1997.

Developments in Non-expected Utility Theory: the hunt for a descriptive theory of choice under risk, Journal of Economic Literature, XXXVIII, 332-382, 2000.

Do Anomalies Disappear in Repeated Markets? (With G. Loomes and R. Sugden), Economic Journal, 113, C153-C166, 2003.

Testing Explanations of Preference Reversal (with R Cubitt and A Munro), Economic Journal, 114, 709-26, 2004.

Testing competing models of loss aversion: An adversarial collaboration (with I. Bateman, D. Kahneman, A. Munro, and R. Sugden), Journal of Public Economics, 89, 1561-80, 2005.

Third-Generation Prospect Theory, (with U. Schmidt and R. Sugden), Journal of Risk and Uncertainty, 36, 203-223, 2008.

Market Experience Eliminates Some Anomalies - And Creates New Ones (with J. Braga and S. Humphrey), European Economic Review, 53, 410-16, 2009.

Are Experimental Economists Prone to Framing Effects? A Natural Field Experiment, (with S Gächter, H. Orzen, E. Renner and C. Starmer), Journal of Economic Behaviour and Organization, 70, 443-46, 2009.

Explaining Focal Points: Cognitive Hierarchy Theory versus Team Reasoning, (with N. Bardsley, J. Mehta, C. Starmer and R. Sugden), Economic Journal, 120, 40-79, 2010.

Are Bygones Bygones? (with R. Cubitt and M. Ruiz-Martos), Theory and Decision, Online DOI 10.1007/s11238-010-9233-4, 2010.

Incentives, Expertise and Medical Decisions: Testing the Robustness of Natural Frequency Framing (with E. Ferguson), Health Psychology, 32, 967-77, 2013. http://doi.org/10.1037/a0033720

Does Consultation Improve Decision Making? (with A. Isopi and D. Nosenzo), Theory and Decision, 77, 377–388, 2014. http://doi.org/10.1007/s11238-014-9449-9

On Preference Imprecision (with R. Cubitt and D. Martinez Navarro), Journal of Risk and Uncertainty, 50, 1-34, 2015. http:/doi.org/10.1007/s11166-015-9207-6

References

Armel, K. C., Beaumel, A., & Rangel, A. (2008). Biasing simple choices by manipulating relative visual attention. Judgment and Decision Making, 3, 396–403. http://journal.sjdm.org/8319/jdm8319.pdf

Barraclough, D. J., Conroy, M. L., & Lee, D. (2004, April). Prefrontal cortex and decision making in a mixed-strategy game. *Nature Neuroscience, 7,* 404–10. doi:10.1038/nn1209

Bird, G. D., Lauwereyns, J., & Crawford, M. T. (2012). The role of eye movements in decision making and the prospect of exposure effects. *Vision Research, 60,* 16–21. doi:10.1016/j.visres.2012.02.014

Elliott, R., Agnew, Z., & Deakin, J. F. W. (2008). Medial orbitofrontal cortex codes relative rather than absolute value of financial rewards in humans. *European Journal of Neuroscience, 27,* 2213–2218. doi:10.1111/j.1460-9568.2008.06202.x

Fisher, G., & Rangel, A. (2014). *The multi-attribute attentional drift diffusion model of consumer choice.* Manuscript submitted for publication.

Glaholt, M. G., & Reingold, E. (2009). Stimulus exposure and gaze bias: A further test of the gaze cascade model. *Attention, Perception, & Psychophysics, 71,* 445–450. doi:10.3758/APP.71.3.445

Hopper, L. M., Lambeth, S. P., Schapiro, S. J., & Brosnan, S. F. (2014, November). Social comparison mediates chimpanzees' responses to loss, not frustration. *Animal Cognition, 17,* 1303–11. doi:10.1007/s10071-014-0765-9

Hunt, S., Stewart, N., & Zaliauskas, R. (2015). Two plus two makes five? Survey evidence that investors overvalue structured deposits. *Financial Conduct Authority Occasional Papers in Financial Regulation, 9.* http://www.fca.org.uk/your-fca/documents/occasional-papers/occasional-paper-9

Knutson, B., Taylor, J., Kaufman, M., Peterson, R., & Glover, G. (2005). Distributed neural representation of expected value. *Journal of Neuroscience, 25,* 4806–4812. doi:10.1523/JNEUROSCI.0642-05.2005

Krajbich, I., & Rangel, A. (2011). Multialternative drift-diffusion model predicts the relationship between visual fixations and choice in value-based decisions. *Proceedings of the National Academy of Sciences, 108,* 13852–13857. doi:10.1073/pnas.1101328108

Krajbich, I., Armel, C., & Rangel, A. (2010). Visual fixations and the computation and comparison of value in simple choice. *Nature Neuroscience, 13,* 1292–1298. doi:10.1257/aer.104.5.501

Lim, S.-L., O'Doherty, J. P., & Rangel, A. (2011). The decision value computations in the vmPFC and striatum use a relative value code that is guided by visual attention. *Journal of Neuroscience, 31,* 13214–13223. doi:10.1523/JNEUROSCI.1246-11.2011

Maccheroni, F., Marinacci, M., & Rustichini, A. (2012). Social decision theory: Choosing within and between groups. Review of Economic Studies, 79, 1591-1636. doi:10.1093/restud/rds006

Mullett, T. L., & Stewart, N. (2015). *Implications of visual attention phenomena for models of preferential choice.* Manuscript submitted for publication.

Mullett, T. L., & Tunney, R. J. (2013). Value representations by rank order in a distributed network of varying context dependency. *Brain and Cognition, 82,* 76–83. doi:10.1016/j.bandc.2013.02.010

Mullett, T. L., & Tunney, R. J. (2015). *Visual attention and information weighting in multi-attribute choice.* Manuscript submitted for publication.

Navarro-Martinez, D., Salisbury, L. C., Lemon, K. N., Stewart, N., Matthews, W. J., & Harris, A. J. L. (2011). Minimum required payment and supplemental information disclosure effects on consumer debt repayment decisions. *Journal of Marketing Research, 48,* S60-S77. doi: 10.1509/jmkr.48.SPL.S60

Padoa-Schioppa, C. (2009). Range-adapting representation of economic value in the orbitofrontal cortex. *Journal of Neuroscience, 29,* 14004–14014. doi:10.1146/annurev-neuro-061010-113648

Pitt, M. A., Woojae, K., Navarro, D., & Myung, J. I. (2006). Global model analysis by parameter space partitioning. *Psychological Review, 113,* 57–83. doi:10.1037/0033-295X.113.1.57

Price, S. A., & Brosnan, S. F. (2012). To each according to his need? variability in the responses to inequity in non-human primates. *Social Justice Research, 25,* 140–169. doi:10.1007/s11211-012-0153-z

Ratcliff, R. (1978). Theory of memory retrieval. *Psychological Review, 85,* 59–108. doi:10.1037/0033-295X.85.2.59

Reutskaja, E., Nagel, R., Camerer, C. F., & Rangel, A. (2011). Search dynamics in consumer choice under time pressure: An eye-tracking study. *American Economic Review, 101,* 900–926. doi:10.1257/aer.101.2.900

Shimojo, S., Simion, C., Shimojo, E., & Scheier, C. (2003). Gaze bias both reflects and influences preference. *Nature Neuroscience, 6,* 1317–1322. doi:10.1038/nn1150

Stewart, N., Gächter, S., Noguchi, T., & Mullett, T. L. (2015). Eye movements in strategic choice. *Journal of Behavioral Decision Making.*

Stewart, N., Hermens, F., & Matthews, W. J. (2015). Eye movements in risky choice. *Journal of Behavioral Decision Making.* doi: 10.1002/bdm.1854

Teodorescu, A. R., & Usher, M. (2013). Disentangling decision models: From independence to competition. *Psychological Review, 120,* 1–38. doi: 10.1037/a0030776

Tremblay, L., & Schultz, W. (1999, April 22). Relative reward preference in primate orbitofrontal cortex. *Nature, 398,* 704–708. doi:10.1038/19525

Wang, J. T. Y., Spezio, M., & Camerer, C. F. (2010). Pinocchio's pupil: Using eyetracking and pupil dilation to understand truth telling and deception in sender-receiver games. *American Economic Review, 100,* 984–1007. doi:10.1257/aer.100.3.984

Zajonc, R. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9,* 1–27. doi:10.1037/h0025848

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which.co.uk

23 June 2015

Dear ESRC,

Re. letter of support for Warwick University's "Accumulating to Choose" project

Which? is the largest consumer organisation in Europe with over 800,000 members. We operate as an independent, a-political, social enterprise working for all consumers and funded solely by our commercial ventures. We receive no government money, public donations, or other fundraising income. Which?'s mission is to make individuals as powerful as the organisations they have to deal with in their daily lives, by empowering them to make informed decisions and by campaigning to make people's lives fairer, simpler and safer.

The collection and use of consumer data is a core concern for Which? The Warwick Accumulating to Choose project is therefore one we are extremely pleased to support strongly. The detailed understanding of the accumulation of evidence in financial choices involving money, risk, and time, and in consumer choices between products provides a framework for us to understand how and why people might go wrong, and what interventions, changes or support can be put in place to create a more favourable environment for their decisions. In particular, understanding the link between eye movements and attention and choice can help our identification and assessment of the aspects of marketing and promotional information that will have the largest impact on decisions.

Protecting and empowering consumers is an area in which we actively develop policy and (successfully) campaign in to drive better outcomes for consumers. Understanding of the complexity of financial products affects consumer choices is key in ensuring that people are making wise and informed financial decisions. The collaboration with Warwick will help us contribute to the public policy debate about the use of behavioural economics in the regulation of financial products, and particularly to the emerging theme around the complexity of financial products.

We plan to use this research in a variety of ways:

- To inform the development of policy and practical mechanisms to support consumers to make more informed decisions, while protecting those who can't
- To inform the development of campaigns to influence policy makers, government and regulators and business to achieve positive change for consumers
- To translate the findings into accessible guidance for the UK public at large, through our various online and offline channels e.g. our Consumer Rights website, Money Helpline, Money magazine, Computer Helpdesk and Computing magazine and the main Which? website and magazine
- To develop our own research base by collaborating with Warwick on field trials

We have a strong and formal relationship with Warwick University and we are very excited about being involved in the Accumulating to Choose project.

Yours sincerely,
Alex Chesterfield
Alexandra Chesterfield
Head of Behavioural Insights, Which?

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Economic and Social Research Council
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05 October 2015

Dear ESRC,

The Financial Conduct Authority would like to support the "Accumulating to Choose" proposal, and would work with Profs. Stewart, Starmer, and Camerer to develop field trial applications based on their scientific programme.

The Financial Conduct Authority regulated the financial services industry under the 2012 Act of Parliament, with objectives of protecting consumers, protecting financial markets, and promoting competition. I head the Behavioural Economics and Data Science unit which applies these methods to financial regulation.

The Behavioural Economics and Data Science unit has collaborated with Stewart in the past in our investigation of the structured deposits market. We demonstrated that consumers struggle to value and understand these projects, as reported in our Financial Conduct Authority occasional paper "Two plus two makes five? Survey evidence that investors overvalue structured deposits", which headlined in the Financial Conduct Authority's structured products thematic review.

The field trials we develop must inform the regulation of financial services, improving the provision to the UK public. To that end, we would work closely with the "Accumulating to Choose" team to translate their scientific findings into policy relevant randomised control trials, driven by the Financial Conduct Authority's regulatory agenda at the time of translation. We intend to disseminate the results via our Occasional Paper Series, which has a broad reach across professionals in the financial services. The "Accumulating to Choose" project would also have access to data sets held within the Financial Conduct Authority to explore real world examples of

attentional phenomena with a view to developing further policy relevant interventions.

We support the "Accumulating to Choose" proposal most strongly, and will devote staff time and expertise in collaborating.

Yours faithfully,

Dr. Stefan Hunt
Head of Behavioural Economics and Data Science
Financial Conduct Authority

Date
29 September 2015

THE UKCARDS ASSOCIATION

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Economic & Social Research Council Selection Panel
Polaris House
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Accumulating to Choose Project

Dear ESRC Selection Panel,

The UK Cards Association is the trade association for the cards payment industry in the UK. We have a membership that includes all major credit, debit and charge card issuers and card payment acquirers. The Association helps in legislative and regulatory policy formation, develops industry best practice, safeguards the integrity of card payments, develops industry standards and coordinates other industry-wide initiatives on non-competitive issues across matters relating to card payments and the provision of credit.

We are writing to support the project *Accumulating to Choose* with Profs. Stewart, Starmer, and Camerer. We are currently collaborating with Prof. Stewart by sharing a large data set containing transaction-level information for hundreds of thousands of UK cardholders. We would seek to develop applications of the *Accumulating to Choose* project in the domain of credit card provision. Possible applications include the role of attention in card activation calls (where cardholders make decisions about establishing direct debits, etc.), on the design of communications between card providers and their customers, and on assistance targeted at cardholders in or approaching difficulty.

We already have a track record with Prof. Stewart of using his research to inform public policy debate. We invited Prof. Stewart to present the research to our public affairs group on several occasions and also to submit a written summary of the research leading up to our response to the Government's White Paper "A better deal for consumers". The research was an important part of the comprehensive evidence base that we submitted in our response to the White Paper in early 2010. Part of our argument was that the research indicated that the proposed changes in minimum payment policy would have a counter-intuitive effect on the repayment behaviour of a large proportion of card holders, not just those making minimum repayments. The resulting "joint commitment" between the Government and the industry covers all credit card providers in the UK and has set standard for the setting and treatment on minimum payments across the industry.

The work undertaken by Prof Stewart has significantly influenced leading policy makers within Government and radically altered the initial proposed approach and assumptions in existence before his work. The research credibly demonstrated a number of unexpected inadvertent consequences of the initial proposals within the Government's consultation that would have had adverse impacts on large populations of credit cardholders. In essence, the work of Prof. Stewart introduced a whole new dimension in to the thinking around this important area, both from the perspective of Government and credit card providers. For this reason, we are keen to continue our work with Prof. Stewart by collaborating on the development of this route to impact for the *Accumulating to Choose* project.

Yours faithfully

Richard Koch
Head of Policy

Statement of Support from PRICE Lab, ESRI, Ireland

The Economic and Social Research Institute (ESRI) is Ireland's national research institute. It was established over 50 years ago specifically to provide independent evidence for policy.

PRICE Lab is the "Programme of Research Investigating Consumer Evaluation". It is funded by Ireland's four main economic regulators: the Central Bank, the Competition and Consumer Protection Commission, the Commission for Energy Regulation and the Communications Regulator (ComReg). The programme uses laboratory experiments to investigate consumers' capabilities. Our research directly informs policymakers in Ireland (and sometimes elsewhere), in relation to consumers' capabilities when dealing with complex products. PRICE Lab began by investigating research questions of relevance across markets, including: (1) How large does a surplus have to be before consumers can reliably identify it? (2) How does this vary by number of attributes? (3) How does it vary by type of attribute (e.g., visual, categorical, numeric, non-linear, etc.)? (4) Are there systematic biases in the way consumers map attributes to prices?

This initial work has been used by the funders in Ireland to inform policy. For instance, it has informed regulations surrounding the introduction of smart meters for energy which, while they holds the promise of increased household energy efficiency, risk increasing complexity in the market and thereby making it harder for consumers to identify good deals. In more recent work PRICE Lab has designed experiments to test consumers' abilities in specific product markets that are causing concern for regulators. We have conducted an experiment on how discounting prices from standard rates affects choice of electricity provider and on how the framing of financial cost information affects choice in the market for personal loans. We are presently undertaking experiments on how the bundling of handsets into mobile phone plans affects consumers' choices.

PRICE Lab has frequent direct contact with multiple government agencies and stakeholders across different areas of economic regulation, not only in Ireland. We have received requests for papers, presentations and advice from regulators in multiple European countries, the Financial Conduct Authority in the UK, the European Commission and the OECD. Our experience is that policymakers have a growing interest in applying experimental methods to policy questions.

We are enthusiastic and willing to collaborate with established researchers with good track-records in judgement and decision-making and who are keen to see their work applied to policy. From an international perspective, our view is that the research teams at the University of Warwick and at Caltech are first-rate and we would, therefore, be delighted to collaborate with them.

The present case for support aims to generate insightful new empirical methods for understanding how consumers make choices. Our expertise is in taking empirical methods developed in various parts of the scientific literature and applying them to current policy problems. Thus, a collaboration like the one envisaged has the capacity to forge beneficial new links between rigorous academic study and policymaking.

Dr. Pete Lunn, Principal Investigator, PRICE Lab.

Progress Report on ES/K002201/1 for Neil Stewart, University of Warwick

The Network for Integrated Behavioural Science (NIBS) is an ESRC investment, funded under the Centres and Large Grants Competition. It is a partnership among the Universities of Nottingham, Warwick and East Anglia. It brings together teams of economists, psychologists, and computer and complexity scientists with track records of multilateral collaboration. NIBS aims to develop and test cross-disciplinary models of human behaviour and behaviour change; and to draw out their implications for public policy formulation and evaluation. The key objectives of the Network are to provide: (a) A forum for cutting edge cross-disciplinary and cross-institutional academic collaboration on behavioural science; (b) Research outputs that will aid prediction of human behaviour and inform those seeking to influence it; (c) Access to a high calibre, inter-disciplinary team of behavioural scientists.

The Network has been in operation for two and a half years (since 31 December 2012). In terms of Network capacity we recruited a Network Administrator (commenced April 2013) and in Spring/ Summer 2013, we successfully hired six postdoctoral research fellows, with further recruitment in April 2014 and May 2015 to replace posts. These fellows brining expertise spanning economics, psychology, anthropology, sociology and neuroscience. In addition, we recruited four PhD students from economics and psychology. We have also developed core infrastructure, including development of a Network website, improvement of lab facilities, and development of a mobile lab.

We have held external facing conferences in spring 2014 (themed "individual and household financial decision making and behaviour in financial markets") and 2015 (themed "behavioural science and policy"). We have also held internal workshops in autumn 2013 (a start-up where new postdocs present their work and NIBS projects were developed) and 2014 (reporting funded projects and developing the next wave), and will hold an additional internal workshop in September 2015.

New collaborative work within the Network has been stimulated through two main mechanisms. First, after the initial start-up event (hosted at Warwick in 2013) we established 14 working groups to pursue specific issues highlighted in the Case for Support. Second, the tri-annual bidding process for allocation of shared resources. This has so far funded 28 specific projects (over 6 rounds).

Work of NIBS researchers is regularly monitored via an internal review process which requires annual activity reports from each co-investigator. These are reviewed by each of the four Theme Leaders to assess coverage of the research plan under each of the themes set out in the case for support. Based on this review process, we have identified some areas where we need to initiate new research streams to meet our long-run objectives. Work is well-established for each of the four themes. We are successfully developing cross-institution and cross-disciplinary working, though it will be a continuing objective of the Network to extend and deepen these linkages. There is clear evidence of research progress and potential. In the annual report (period ending March 2014) we provide specific examples of where we have established a foothold relative to fundamental theoretical and conceptual issues which lie at the heart of our programme.

We have already published multiple NIBS related outputs in high quality scientific journals including: *Econometrica*, *American Economic Review*, *Journal of Economic Perspectives*, *European Economic Review*, *Management Science*, *Journal of Experimental Psychology: General* and *Psychological Science*. See the NIBS website for details of publications.

Members of NIBS have been active in promoting our work through outreach activities including presentations at relevant international conferences and workshops; and appearances as keynote speakers. They have also been seeking to stimulate and contribute to broader public debate through prominent media outlets. For example, three NIBS researchers featured as the primary contributors to the BBC Radio 4 programme ‘The Human Zoo; one contributed to the Radio 4 programme ‘The

Bishop and the Bankers'; and one participated in a Radio 5 live discussion on the topic of consumer 'switching behaviour'. We are also engaged with public decision-making. For example: Stewart presented work related to household financial decision making at HMRC and has co-authored an policy paper with the Financial Conduct Authority; Starmer participated in the event "Social Science in Parliament: Improving the Evidence Base for Policy" hosted by the Parliamentary Office of Science and Technology; Gathergood was appointed 'Senior Academic Advisor' to the Financial Conduct Authority's "Rate Cap" project. We also co-sponsored one such event on 'Valuing Life, Health and Safety in Public Policy: Issues and Challenges', British Academy, London including participants from NIBS, the Health and Safety Executive and the Department of Transport.

We are also developing projects which involve direct research collaboration with partners in public, private and third sector organisations including: Capital One and Experian where we have agreement in principle for the development of three projects involving input from NIBS economists, psychologists and computer scientists; the Financial Conduct Authority with projects on consumer understanding of structured deposits and welfare impacts of pay day loans. We are also developing a large-scale project on data insight with the credit counselling industry. We are also working on promoting healthy behaviour with the Department of Health Policy Research Programme and the UKCRC Centre for Diet and Physical Activity Research.

We have set in motion an ambitious programme of capacity building initiatives which has involved induction and training for our new (research and administrative) staff; involvement of junior and mid-career staff in Network management and decision making; providing opportunities for external junior researchers to interface with NIBS (via events) and supporting opportunities for junior NIBS researchers to engage with other researchers and Networks beyond NIBS.

The NIBS network has supported three main types of international activity: (i) international visitors; (ii) international research collaboration (iii) events with international participation. We expect to significantly expand such activity during the next years of operation as our exchange programme develops. During the coming year we intend to prioritise initiating research in gap areas and the development of the international exchange programme.

Specific Contributions of Applicant
Since the start of the project, Stewart had undertaken a range of NIBS activities including:

NIBS Funded Projects
1. Accumulators, with Loomes, Starmer, Mullett, Bhatia, Alempaki, Tufano. Experimental and modelling work completed and first draft of publication completed.
2. Shaping, with Isoni, Loomes, Starmer, Cubitt, Sugden. Experiment complete and writing in progress.
3. Eye tracking games, with Gaechter and Mullett. Initial experiment now published in Journal of Behavioural Decision Making.
4. Household finance. Gathergood and Stewart, with Brown, Read, Aickelin. Reports co-authored by NIBS and the FCA on payday lending and structured deposits are now published by in the FCA Occasional Paper Series.
5. Credit cards. Gathergood and Stewart have collaborated with the UK Cards Association to obtain a massive data set (10% of all credit card transactions in the past six years) from which to build a series of projects between NIBS and the credit card industry.
6. Real choices, with Bhatia and Mullett. Ten laboratory experiments are completed and being written up. The project is being extended to store card big data.

Publications supported by NIBS (* is NIBS member)
Mullett*, T. L., & Stewart*, N. (2015). *Implications of visual attention phenomena for models of preferential choice.* Manuscript submitted for publication.

Quispe-Torreblanca, E. G., Stewart*, N., Birnbaum, M. H., Navarro-Martinez, D., Ungemach, C., & Proto, E. (2015). *One-Shot violations of stochastic dominance resist detection training*. Manuscript submitted for publication.

Hunt*, S., Stewart*, N., & Zaliauskas, R. (2015). Two plus two makes five? Survey evidence that investors overvalue structured deposits. *Financial Conduct Authority Occasional Papers in Financial Regulation, 9.* http://www.fca.org.uk/your-fca/documents/occasional-papers/occasional-paper-9

Reimers, S., & Stewart*, N. (2015). Presentation and response timing accuracy in Adobe Flash and HTML5/JavaScript web experiments. *Behavior Research Methods, 47,* 309-327. doi: 10.3758/s13428-014-0471-1

Stewart*, N., Gächter*, S., Noguchi, T., & Mullett*, T. L. (in press). Eye movements in strategic choice. *Journal of Behavioral Decision Making*.

Stewart*, N., Hermens, F., & Matthews, W. J. (2015). Eye movements in risky choice. *Journal of Behavioral Decision Making*. doi: 10.1002/bdm.1854

Stewart*, N., Reimers, S., & Harris, A. J. L. (2015). On the origin of utility, weighting, and discounting functions: How they get their shapes and how to change their shapes. *Management Science, 61,* 687-705. doi: 10.1287/mnsc.2013.1853

Stewart*, N., Ungemach, C., Harris, A. J. L., Bartels, D. M., Newell, B. R., Paolacci, G., & Chandler, J. (in press). The average laboratory samples a population of 7,300 Amazon Mechanical Turk workers. *Judgment and Decision Making*.

Walasek*, L., & Stewart*, N. (2015). How to make loss aversion disappear and reverse: Tests of the decision by sampling origin of loss aversion. *Journal of Experimental Psychology: General, 144,* 7-11. doi: 10.1037/xge0000039

Gherzi, S., Egan, D., Stewart, N., Haisley, E., & Ayton, P. (2014). The meerkat effect: Personality and market returns affect investors' portfolio monitoring behavior. Journal of Economic Behavior & Organization, 107, 512-526. doi: 10.1016/j.jebo.2014.07.013*

Noguchi, T., & Stewart*, N. (2014). In the attraction, compromise, and similarity effects, alternatives are repeatedly compared in pairs on single dimensions. *Cognition, 132,* 44-56. doi: 10.1016/j.cognition.2014.03.006

Noguchi, T., Stewart*, N., Olivola, C. Y., Moat, H. S., & Preis, T. (2014). Characterizing the time-perspective of nations with search engine query data. *PLoS ONE, 9,* e95209. doi: 10.1371/journal.pone.0095209

Conferences

Date	Title of Presentation	Name of Conference	Venue
July 2015	Expected utility estimated with generalized linear mixed-effects models	Birkbeck Cognitive Modelling	Birkbeck
May 2015	How to Make Loss Aversion Disappear and Reverse	Basel Decision Making and Memory Workshop	Basel
April 2015	Eye movements, lab choices, and big data approaches to decision making research	Oxford Experimental Psychology Seminar	Oxford
Sept 2014	Structured deposits	NIBS	Warwick
Sept 2014	Naturalistic multiattribute choice	Decision Making Bristol 2014	Bristol
Sept 2014	Loss aversion is a property of the experimental design, not the participant	Decision Making Bristol 2014	Bristol
Sept 2014	The psychology of nations and states	Decision Making Bristol 2014	Bristol
July 2014	Loss aversion is a property of the experimental design, not the participant	BDRM Conference	London
May 2014	The psychology of nations and states	Stirling ESRC Workshop	Stirling
March 2014	Behavioural science in public policy regulation	DG FISMA Behavioural Insights Briefing Session	Brussels
April 2014	The psychology of nations and states	Basel, Reiskamp group	Basel

Interim Report
Combination Rules in Information Integration
[ES/K004948/1]

We are currently a twenty-two months into a thirty-six month project and we are on track with our research plan. Updates on each of our three programmes of research as well as our preparation for publication and our presentations at national and international conferences are detailed below.

Programme 1: Cognitive and perceptual tasks. We have investigated how to improve participants' combination of information using various task manipulations to investigate how well participants combine two diagnostic pieces of information in addition to how well participants combine a diagnostic piece of information with a non-diagnostic piece of information. In our experiments so far, we have used stimuli such as rectangles, dominoes, and ice cream cones and found a variety of effects. Our ice cream cone experiments, for example, asked participants to look at what two shops had sold during the day and then to judge the relative likelihood that a particular ice cream, cone, or ice cream cone was sold from one shop relative to the other.

Combining two pieces of diagnostic information, called the set-size effect, should result in participants having a stronger impression of the combined evidence than either piece of diagnostic evidence alone. For ice cream cone experiments, a cone and an ice cream that are diagnostic of a particular shop should result in a stronger impression than just the ice cream or cone alone. We found that the probability that participants would come to the correct answer depended on the physical presentation of the shops. If ice cream and cones were presented together, then participants were more correct than if ice creams and cones were presented separately. These experiments show what sort of display can be used to avoid this type of integration error.

Combining a diagnostic piece of evidence with a non-diagnostic piece of evidence is known as the dilution effect. Here our experiments have found that participants solve this task differently than in the above task and in previous literature on this topic. We found the dilution effect, but surprisingly it was not due to inaccurate combination of diagnostic and non-diagnostic information. People were accurate at judging diagnostic evidence combined with non-diagnostic evidence, but overestimated the strength of diagnostic evidence alone. We can explain this within-participants dilution effect as the result of inference about missing features rather than incorrect combination of information and are currently investigating how to encourage participants to reason correctly for this task.

The preliminary results of this programme were presented at the Cognitive Science Society meeting in the USA this summer. The final results will be submitted for publication when we have further investigated how to remove the dilution effect.

Programme 2: Combination rules in economic choice. In this programme, we investigated how participants combine probability and utility in gambles. A critical gap in our understanding of economic decision-making is for tasks that require us to choose between gambles rather than assign a monetary valuation to a single gamble. Previous investigations of economic choice have used simple tasks for which the combination rule is confounded with assumptions about how variable our decisions are and whether the values are transformed before they are combined (Stewart, 2011).

We have used participant choices between three-branch gambles (e.g., "A: 50% chance of £200 otherwise £100" or "B: 30% chance of £400 otherwise £50") to investigate this question, which disambiguates the identifiability problem that arises from decision variability. We have also used models based on Cumulative Prospect Theory (Tversky & Kahneman, 1992), which assumes that values and probabilities are transformed before being combined together multiplicatively. We are allowing for a range of possible transformations and using a Bayesian model comparison to investigate how much a multiplicative

and an additive rule contribute to how participants value gambles in choice paradigms. The results of our analyses have shown that the multiplicative rule alone is enough to describe participant behavior, in contrast to other researchers who claim that additive combination is the default human behavior.

These results, and further investigations into which gambles are best for distinguishing additive and multiplicative models, are being prepared for publication.

Programme 3: Averaging over combination rules. Our third programme aims to take a closer look at whether participants' evaluations of the probability of two outcomes is the result of a single combination rule or whether it is a strategic averaging of combination rules. We collected data on how participants combine probabilities into conjunctions and disjunctions, following the classic design of Wyer (1976) who asked participants for the probabilities of events described by the words "rarely", "sometimes", and "usually" as well as the probabilities of all possible conjunctions and disjunctions of these words.

Previous work has argued about which strategy participants in these tasks use to combine probabilities. Some popular ideas are that participants report the normative answer with noise, they report the average, or they report the most 'surprising' single probability. In a closer analysis of the data, we found that participants used a variety of combination rules. At an individual level our Bayesian analysis showed that, when only considering single strategy models, most participants appear to use either the normative or surprise strategy. Broadening our analysis to include the possibility that people use multiple strategies revealed that (a) it is more probable for the vast majority of participants that multiple strategies were used and (b) most people used a combination of surprise and the normative strategy, or a combination of all three strategies.

We are currently analysing the results of experiments that provide participants with different types of reward schemes in order to understand how participants are combining strategies together and to encourage participants to respond more normatively. Participants could potentially be sampling strategies individually or they could be taking some sort of average of different strategies to come up with an aggregate response.

The work from this programme is currently being prepared for publication. Experimental results were presented at Bristol Decision Making 2014 and were presented at conferences and seminars at UK universities (Warwick and UCL) and at North American conferences (Society for Mathematical Psychology and Cognitive Science Society) this spring and summer.

Conference Presentations

2015 Annual Conference of the Cognitive Science Society, California, USA: 'Multiple Strategies in Conjunction and Disjunction Judgments: Most People are Normative Part of the Time'

2015 Annual Conference of the Cognitive Science Society, California, USA: 'Inference, Not Dilution in the Dilution Effect'

2015 Annual Conference of the Mathematical Psychology Society, California, USA: 'Multiple Strategies in Conjunction and Disjunction Judgments: Most People are Normative Part of the Time'

2014 Bristol Decision Making 2014, Bristol, UK: 'Single or multiple strategies in conjunction and disjunction fallacies?'

Papers

Tripp, J., Sanborn, A., Stewart, N., & Noguchi, T. (in preparation). Multiple strategies in conjunction and disjunction judgments: Most People Are Normative Some of the Time.

Tripp, J., Sanborn, A., Stewart, N., & Noguchi, T. (in preparation). Pay and probabilities: incentive schemes moderate multiple strategy choice in the conjunction and disjunction fallacies.

Tripp, J., Stewart, N., Sanborn, A., & Noguchi, T. (in preparation). CPT is enough.

Tripp, J., Stewart, N., Sanborn, A., & Noguchi, T. (in preparation). Multibranch model mimicry of additive and multiplicative integration of risky decisions.

Noguchi, T., Sanborn, A., Stewart, N., & Tripp, J. (in preparation). Inference, not dilution in the dilution effect.

Data Management Plan

Assessment of Existing Data

There are a number of existing datasets from projects using eye-tracking to measure attention during choice and deliberation. Although these are varied, none use tasks complex enough to address the empirical questions we wish to answer. Our lab has already created a small number of these but it is the combined consideration of these existing datasets which has led us to identify the current deficiencies within the literature. A number of relevant papers can be found in the recent special issue in the Journal of Behavioural Decision Making, including papers from our lab on strategic choice (Stewart, Gächter, Noguchi, & Mullett, 2015) and risky gambles (Stewart, Hermens, & Matthews, 2015). However, the literature reviews within this special issue show no datasets or papers suitable for our purposes.

We have also communicated with a number of eye tracking colleagues at CalTech, Carnegie-Mellon University, University of New South Wales, Auburn University, Max Planck Institute for Human Development and Max Planck Institute for Research on Collective Goods. While these researchers reported a keen interest in the topic, and in any future work, none knew of any datasets which would be suitable for our research questions.

Information on New Data

We envisage creating a range of new datasets. The majority of this data will comprise of eye tracking and behavioural responses (in the form of button presses) during lab based psychology experiments. Behavioural responses will be saved as a separate csv for each participant, with an anonymised id number contained in the file and file name. The eye tracking data will be initially recorded in its native ascii format with status and eye position reported at 2ms intervals. During analysis we will extract all visual fixation information and convert this to a comma delimited csv. This allows for dramatic compression of the file and combining multiple subjects into a single datafile. As it is conceivable that other research questions may require the non-fixation data contained within the original ascii files, we intend to submit both versions for archiving with all subject specific files containing the subject id in the filename.

The only other data we envisage collecting are a small number of accompanying behavioural studies. These will be saved as a single comma delimited csv and archived. At no point will we be collecting any personal or identifying information, so subsequent anonymisation is not necessary.

Quality Assurance of Data

The data collection methods we propose are already largely automated, leaving little room for human error or transcription problems. By far the largest concern with eye tracking data is accounting for the calibration parameters and quality for each individual participant. We shall include the recorded calibration parameters in each datafile provided for archiving and use standard procedures for identifying poorly calibrated individuals.

Backup and Security of Data

Data will be initially recorded on a standalone machine in a security controlled laboratory. It will then be transferred to an analysis computer in a locked office which is automatically backed up in an off-site location as per our institution's procedure.

Data Management Plan

At no point will we record personal or identifying information with any of the data.

Expected Difficulties in Data Sharing

The only potential difficulty we see concerns the sharing and transfer of large datafiles. Due to the data intensive nature of high frequency eye-tracking, data files are often more than 50MB per person and it is not unusual to test 100 subjects. However, as technology improves, this is becoming less of a problem and we can make use of the University of Warwick's existing systems for large file transfers.

Copyright

In line with BPS and APA guidelines we will share data freely with any researchers and individuals who request it. All of the laboratory materials created for the project will be owned by the University of Warwick and shared with those who request them. For impact work, formal agreements will be drawn up at the beginning of all collaborations. We anticipate allowing our collaborators to make full use of any materials generated and wherever possible will ensure that data is still available to be shared and archived. We believe the only potential reasons for not sharing data are privacy and data security concerns.

Responsibilities

Timothy Mullett will be responsible for all aspects of data management, quality issues and delivery of data for sharing and archive.

Preparation of Data for Sharing and Archiving

We will deposit all of the data generated by this grant with the UK data service. All eye tracking data will be encoded in standardized formats including an aggregated csv and original ascii files containing all eye tracker readings and calibration information.

Data Management Plan