**Title**

Generalizability of models of response time

**Project Team Roles & Responsibilities**

* *Lead Investigators*Dr Timothy Ballard (Post Doctorate Research Fellow, The University of Queensland)  
  Responsibilities: Project design, supervising research students and other personnel, data analysis, and mathematical modelling.

Dr David Sewell (Lecturer, The University of Queensland)

Responsibilities: Project design, supervising research students and other personnel, data analysis, and mathematical modelling.

* *Researcher*   
  Ms Gina Fisher (Research Assistant, The University of Queensland)

Responsibilities: Study piloting, participant recruitment, data collection and analysis.

* *Honours students and Summer Research Scholars*  
  Responsibilities: Study piloting, participant recruitment, data collection and analysis.

**Resources**

Participant remuneration at a rate of $20 per hour for testing sessions typically 30 minutes in duration ($10 per participant). Participant remuneration for online participation through Amazon Mechanical Turk at a rate of $5/hour for testing sessions typically 30 minutes in duration ($2.50 per participant).

**Background**

A widely studied phenomenon in experimental cognitive psychology is the speed-accuracy trade-off.

Typically, if a person responds quickly, they cannot process all of the information required to make a fully informed decision, sacrificing accuracy. On the other hand, if people focus on gathering information to make a more accurate decision, they sacrifice response time (Forster, Higgins & Bianco, 2003). Evidence accumulation models have been used to characterise response time and accuracy data for experiments in this area of research. Applying a formal model of the decision-making processes allows us to disentangle the time costs associated with the quality of information driving the decision process (i.e., decisions based on low-quality information or difficult stimuli tend to take longer), and time-costs associated with the decision threshold (i.e., the amount of evidence accumulated before reaching a decision; i.e. may increase under accuracy emphasis).

The aim of this project is to establish how reliable the phenomena predicted by these models are. Recent work has suggested that traditional evidence accumulation accounts of the speed-accuracy trade-off may be incomplete (e.g., Rae et al., 2014), and so a comprehensive review of basic findings is required. In doing so, our results may provide greater generalisability to current findings, with important implications for optimising performance on difficult, time-critical tasks. Experiments that will be conducted involve the administration of a perceptual discrimination task (e.g., judging the orientation of a line as horizontal or vertical, whether a luminance patch is dark or bright, assigning a shape stimulus to a category, or judging the direction of an array of moving dots) with instructions manipulating whether speed or accuracy is emphasised, a common method for eliciting a speed-accuracy trade-off. Analyses will involve observing estimated model parameters and comparisons between competing models at the individual and group level. The experiments we will conduct will replicate this basic design with different manipulations or small modifications. Particularly, we would like to observe whether findings change when introducing different sorts of task incentives or when presenting different kinds of perceptual stimuli. Results will be compared to previous observations to establish the reliability and generalisability of model predictions in the speed-accuracy trade-off literature.

A representative example of an experiment that will contribute to this objective will investigate

the relationship between participant recruitment method and perceptual task performance. We describe this example experiment in detail below, as it provides an illustration of the general procedures that will be shared across all recruitment methods and data collection platforms (i.e., online vs. in the laboratory). Task motivation has been identified as a factor that may play a role in the strategies individuals use to make speeded decisions (Eubanks, Wright & Williams, 2002). This has been examined through manipulating task incentives within the lab environment (i.e. informing participants they will receive one dollar, ten cents, or no money per correct decision). Different methods of participant recruitment are pre-accompanied by different incentives for participation (i.e. course-credit, varying rates of monetary remuneration). In this experiment, we will use recruitment method as an alternative level of incentive to examine possible differences in decision-making behaviour. Through modelling speed and accuracy data, we can observe whether cognitive processes differ depending on participant circumstances (participation incentive and semester time-point, which may serve as a proxy for motivation). Importantly, we can also examine whether the pattern of model predictions that result from lab-controlled incentive manipulations still hold for pre-existing incentives not contrived within a lab environment.

**Project Design**

*Research Project Settings*

The project will be completed in the School of Psychology at the University of Queensland, or via the web through online recruiting platforms, depending on the specific experiment.

*Methodological Approach and Statistical Power Issues*

Our example experiment uses a 2 (start vs. end of semester) by 3 (recruitment method; paid, course-credit, online-paid) by 2 (emphasis; speed vs. accuracy) mixed design, with recruitment method and time-point as between-subject factors and instruction/emphasis as a within-subject factor. Other experiments will feature a similar design with the procedure remaining largely the same. For example, all experiments will share the same basic trial structure, where a perceptual stimulus will be presented on screen until a participant makes a response. Participants will receive feedback about their accuracy and response time via on screen prompts.

Participants will complete a perceptual discrimination task with response time and accuracy measured on each trial. Half of the blocks of trials will instruct participants to respond with an emphasis on speed, and half will instruct participants to emphasise accuracy. Participant groups being tested in person (paid and course-credit) will be alternated after each session to counter-balance any effects due to time-of-day. Groups of participants will also be tested in separate sessions to avoid possible conflicts associated with providing different remuneration to participants (i.e. course-credit participants will be tested separately to paid-pool participants). In every testing session, half of the participants will complete one perceptual task and the other half will complete an equivalent version of the perceptual task with different stimuli for generalisability (e.g., one group will discriminate lines of differing orientations, whereas another will judge the direction of an array of moving dots). Pilot testing will be conducted to confirm that the tasks are equally and appropriately difficult.

*Research Activities*

A representative example of the type of discrimination task participants will complete is the random dot motion task. Participants are required to indicate via a button-press whether dots are streaming towards the left or the right. The stimulus is a circular cloud of white dots on a black background. Difficulty for this task is manipulated by varying the proportion of dots that move coherently in a particular direction. The greater the proportion of coherently moving dots, the easier the decision is to make.

*Rationale for Choice of Methods*

The commonly used tasks and design we have described for this project are suitable for examining the speed-accuracy trade-off, enabling for a large quantity of data to be collected in a small amount of time. Additionally, these methods pose no significant risk to participants.

The reason for opting for a modelling analysis of the participant data is that it provides a way of decomposing choice behaviour (i.e., decision outcomes and their associated response times) into separable components relating to (1) the time course of processing information form a stimuli and (2) the time required to make a decision, given the information that has been considered. This property of the model-based analysis overcomes key limitations in applying conventional statistical analysis to traditional measures of performance (e.g., accuracy and mean response time).

*Participants, Description and Number, and Inclusion/Exclusion Criteria/Recruitment Strategy*

The sample will be recruited via either a) the UQ first year psychology research participation scheme, whereby students enrolled in first year psychology courses sign up on up on a website and receive course credit for participation, b) the UQ paid research participation scheme, whereby members of the UQ local community sign up on a similar website and receive financial remuneration ($20 per hour) for their travel and time spent participating, or c) crowdsourcing platforms such as Amazon Mechanical Turk and recruitment services such as Crowdflower or Qualtrics whereby participants sign up to complete the study via the web and receive financial remuneration ($5 per hour) for their time spent participating. It is expected that participants will range in age from 18-60, with an equal distribution of males and females, and who will have no significant health issues that would affect their ability to provide voluntary, informed consent.

*Participant Commitment*

When participants begin the experimental session, they will read an information screen that describes the task. Participants will then be asked to click a button indicating that they have read and understood the information form, and agree to participate in the research. Participants will be informed at the start of the experiment that they have the right to withdraw from the study at any point in time without repercussions or penalty. They will also be informed that should they feel uncomfortable completing a particular question or task, they are permitted to not respond. All participants will receive a computer information debrief sheet at the completion of the study explaining its purpose.

*Project Duration*

The project is expected to take between 2 to 3 years to complete (i.e., including data collection and model-based analysis of all relevant data).

*Data Collection/Gathering and Techniques*

Demographic information (i.e., participant age and gender) will be collected. All other information collected will comprise button-press responses to a computer-based perceptual task, where people will judge a property of a perceptual stimulus (e.g., whether dots are moving towards the left or right). The button press responses, summarizing decision outcomes and RT, will be stored in a de-identified manner (i.e., by participant number).

*Participant Withdrawal*

Participants are free to withdraw from the study at any time. Should this occur, all data collected up to that point will be destroyed and all remuneration owed to the participant will be paid.

*Data Management*

All information collected from participants will be anonymised. Participants will be given a subject identification number and all identifying information about the participant will be removed. This ensures that it is impossible for participants to be identified with any documentation or reporting from the study. Once the study has been completed, the data will become “open data”. This means the data will be made available, free of charge to anyone interested in the research or who wants to analyse the data themselves. Once it becomes open data, we will not have control over how the data are used, however, prior to becoming open data, all data will be anonymised and therefore all participants will maintain confidentiality and anonymity.

*Outcome Measures*

The outcome measures from this experiment will be the pattern of best-fitting parameter estimates from model-fitting and results of model selection for each condition of the study.

**Results, Outcomes and Future Plans**

*Plans for Return of Results*

Results from the study will be disseminated via scholarly publications. For participants who do not have access to potential publication outlets, they will be provided with an opportunity to have the experimenter forward on a summary of the key findings upon completion of data collection.

*Plans for Dissemination/Publication*

Results of the study will be presented at academic conferences and scholarly journals. Likely outlets include *Journal of Experimental Psychology: General*, *Journal of Experimental Psychology: Human Perception & Performance*, *Psychonomic Bulletin & Review*, and *Attention, Perception, & Psychophysics*.

*Plans for Sharing Data*

Upon request, de-identified data will be shared with other researchers who are interested in modelling the data from this project.