People fail to learn the lesson from the thing they can do, and still can’t do the thing they can’t do.

*A.D.F. Clarke , M. Spilioti, & A.R. Hunt*

*Abstract goes here. Yes, I know the title is rubbish.*

Imagine you have to prepare for one of two simple, equivalent tasks (e.g. throwing a bean bag into one of two target hoops), with the catch that you must prepare for the tasks before you know which one you will be required to complete. The optimal strategy for this problem requires that you estimate your own ability at carrying out the task, and modify your behaviour in relationship to the difficulty of the current tasks. For example, if the two hoops are sufficiently close to one another, you should be confident that you have a good chance of hitting whichever of the two targets you are asked to aim for. However, if the targets are further apart, such that the chance of hitting either target from the midpoint is below 50%, you should switch strategies and go “all in”, standing near one or the other of the hoops. Assuming each of the two hoops is equally likely to be designated as the target, from this position you can be assured a minimum of 50% accuracy on average.

Clarke and Hunt (2015) demonstrated that participants fail to adopt this strategy, or even to modify their behaviour in response to task difficulty. This same failure was observed across three modalities: eye movements and target detection [also see Morvan & Maloney (2012)]; standing position and throwing; and attention and digit memorisation. However, in a fourth experiment, the participants’ task was simplified, to a comparable, but trivial design: two beanbags are placed on a long table and the participant is asked to select a chair to sit on, at which point they will be asked to pick up one of the two bean bags. Clearly, if the bean bags are within arm’s reach when sitting half way between them, the participant should sit there. If they are further apart, it is clear that the participant will not be able to complete either task, and so they should select a bean bag to sit by, and hope that one is selected. Clarke and Hunt (2015) found that all participants used the same, optimal strategy to complete this task.

In the present study, we investigate if people can generalise across tasks and be primed/encouraged to act in a more strategic manner: If participants first carry out the *reaching task*, do they exhibit a transfer of knowledge, and carry out more strategic decision-making behaviour in the *throwing task*? We investigated this possibility in two experiments.

In the first experiment we double-blindly had half the participants first do the reaching task, followed by the throwing task, while the remaining participants only do the throwing task as a control. The second experiment was divided in two sessions: the first one involved an accuracy measuring throwing task followed by the actual/experimental throwing task. The second session replicated the first experiment with some additional steps: half of the participants did the reaching task and then went on to the throwing tasks, while the other half solved a Sudoku puzzle followed by the throwing tasks. This offered no significance to the study itself, other than to keep the participants occupied before doing the throwing task to keep it double-blind.

Priming has been studied extensively reassuring the idea that manipulating or driving unconscious reasoning can lead to controlling behaviour (Bargh, Chen, & Burrows, 1996). Human performance will fluctuate in response to influential information of which they are unaware of (Locke & Latham, 2006), resulting in the subconscious control of their leeway to behave (Bargh & Chartrand, Studying the Mind in the Middle: A Practical Guide to Priming and Automaticity Research, 1997). Animals constantly make decisions and these must be done in such ways that concentrates chances of survival and reproduction as high as possible. Studies have shown animals performing optimal strategies during decision making individually and consensually (Conradt & Roper, Consensus decision making in animals, 2005; Conradt & Roper, Group decision-making in animals, 2003). For human subjects though results have been surprising, with some studies concluding that their behaviour is not optimal when faced with ‘obvious’, intuitive decisions(Tversky & Edwards, 1996; Morvan & Maloney, 2012; Clarke & Hunt, 2015).

Data conveyed in this report builds on a previous research project in which was established that humans generally fail at being optimal during simple tasks (Clarke & Hunt, 2015)**.** In their study, they found that subjects failed at three of four experiments, as they seemed unable to divide their resources across two goals, as opposed to focussing them on a single target, when switching their focus actually entailed efficiency and optimality. This is incongruent with evolutionary theories and proves opposite to an organism’s survival. In the fourth task (the only successful one) participants had to choose, between three chairs, where to sit alongside a long table in order to reach for one out of two identical beanbags placed on that table. Only when asked to reach for the central beanbag where they supposed to sit in middle chair, and for the other two they had to choose a side chair (see Figure). They knew the targets would be further from arm’s length if seated in the central chair, connoting the reduction of success to chance. In the throwing task they had to throw a randomly specified beanbag in one of two of its corresponding hoop (see Figure). As task difficulty increased (i.e. the further apart the two hoops were) they were expected to allocate their standing position, and hence aim, to one of both hoops. The reaching task was the only successful one, demonstrating the ability of humans to behave logically, while the majority failed in the throwing task. The finding that human subjects are unable to intuitively fixate on maximizing probabilities of success is incongruent with evolutionary theories and ultimately proves detrimental to an organism’s survival.

**Experiment 1**

**Methods**

***Participants***

**32** students from the University of Aberdeen were recruited either via ORSEE (Online Recruitment System for Economic Experiments) or SONA (Sona Systems Research Management System). Participants had no prior knowledge of the hypothesis of the experiment. They were randomly assigned to either the primed group (those who did the reaching task first and then the throwing task) or the control group (those who did only the throwing task), with 16 in each group. There was a £5 remuneration given to the ORSEE subjects, and appropriate academic credits awarded to the SONA subjects.

***Materials and Procedure***

Two experimenters conducted this study. The first experimenter carried out the *reaching task* (detailed below) with half of the participants. The other half were entertained for five to ten minutes to ensure that the second experimenter would not be able to tell if the participant had carried out the reaching task or not. The second experimenter carried out the *throwing task* with both groups of participants.

*Reaching Task*: Six PVC beanbags of three colours (two red, two yellow and two blue) were placed on a long table equidistant from each other (Figure 1). At the centre of the table were the red beanbags, halfway over each side of the table were the yellow beanbags (one on each side), and at the far end were the blue beanbags (one on each end). Three chairs were positioned alongside the table: one on each end (opposite the blue beanbags) and one in the centre (opposite the red beanbags). In order to make sure participants were aware of their own reaching span, they were first asked to sit on the chair positioned at the centre of the table. With their back always touching the chair they were asked whether they could reach and touch the red, yellow and blue beanbags individually. They were then asked to stand up before starting the main part of the experiment. They were told a colour, and that they had to choose a chair to sit on, at which point they would be told which of the two beanbags of the target colour was the target. This was repeated for each colour. The order of the colour-location combination was the same for each participant starting from the middle beanbag and working towards the sides. Once all three colours had been tested, they were given the beanbags and instructed to go to the other experimenter for the second part of the experiment.

*Throwing task*: The experiment took place in an outdoor, sheltered area of concrete slabs within the property of the University of Aberdeen (Figure 1). The slabs (measuring 0.46 x 0.61m) were useful for discreetly marking and recording hoop placement and standing positions, respectively. Six hoops with a diameter value of 0.40m were taped down in a row with three slabs distance between them. The red hoops were 4.60m apart (10 slabs), the yellow hoops were 8.28m apart (18 slabs) and the blue hoops were 11.96m apart (26 slabs). Each participant threw the beanbags a total of 45 times, 15 tosses for each distance, in a random order. They were not told which side their target was until after they chose their standing position. The experimenter stood further back and kept a record of task success and/or failure and standing position.

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| Figure 1. Illustration of methods. Reaching task: The participant selects a chair from which to pick up one of two objects on a long table (Figure 1A). When the two objects are close together at the centre of the table, the optimal choice is the centre chair, but for objects spaced too far to reach from centre, participants should select a chair close to one of the two objects. Throwing task: the goal is to get a bean-bag into one of two hoops (Figure 1B). Participants must first choose a place to stand, and are then told which of the two hoops is their target. If the hoops are close together, the optimal place to stand is halfway between them. As the distance between hoops increases, the optimal behaviour is to choose to stand near one or the other hoop. | |

**Results**

All participants correctly carried out the *reaching task*. When they were asked to reach for the red beanbag they sat in the central chair. When the distance between the beanbags was larger, they moved to either the left or right side chairs, resulting in a 50% success rate. This replicated the behaviour observed by Clarke & Hunt (2015).

Results for the *throwing task* are show in in Figure 2. The optimal solution to this problem would give standing position = 0 for the closest hoop distance, and standing position 1 for the furthest. It is clear from Figure 2 that participants fail to adopt this strategy, replicating the findings of Clarke & Hunt (2016). We were interested in whether participants would be able to learn from their optimal performance in the reaching task, to adopt a more optimal strategy in the throwing task, but it is clear from the results from the primed group that participants fail to do so.

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| Figure 2. Decision results for the throwing task. Each coloured line represents the mean standing position for each of the individual participants in each group, for each of the three pairs of hoop distances. A standing position of 0 corresponds to a participant standing exactly half way between the two hoops on a given trial, where a position of 1 indicated that they stood right over one of the two hoops. Neither the unprimed (who did not do the table task first) nor the unprimed group (who did) adopted optimal behaviour. |

Although neither group could be described as optimal, it does appear the primed group has modified their standing position with distance more than the unprimed group. We look at this more closely in Figure 3, which shows that participants in the primed group do move further from the centre when we compared the difference in standing position between the shortest and longest hoop distances (t(18.7) = 2.14, p=.048). This suggests there is an effect of experience making optimal decisions in the table task on decisions about standing position in the throwing task. However, the effect is small and participants are still far from optimal even in the primed group. We therefore tested this further in a second experiment.

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| Figure 3: Boxplot showing change in standing position between slab=5 and slab=13. |

**Experiment 2**

Experiment 2 also examined whether performing optimal decisions on the reaching task would lead to more optimal decisions in the throwing task. In an effort to increase the likelihood that participants would transfer their learning to the new context, we included an extra initial session with the throwing task, before (half of) the participants carried out the reaching task. Our hypothesis was that prior familiarity with the throwing task would help facilitate insight when completing the reaching task.

**Methods**

Participants carried out this experiment over two sessions approximately one week apart. The first session consisted of two bean bag throwing tasks, one to measure each participant’s throwing accuracy, and the other to investigate our actual throwing paradigm. In the second session, half the participants carried out the reaching task, followed by the throwing experiment, while the other half were given a Sudoku to complete before carrying out the throwing task. The session ended with another block of accuracy measurement. Additionally, participants in the Sudoku condition completed the reaching task at the end of the experiment, to confirm that they were indeed able to successfully execute the optimal strategy.

In the first session participants stood in the middle of the area and threw six beanbags for each of four different hoop distances (*enter hoop distances)*, in increasing order. The beanbags were cleared out of the way after each trial. They then performed the same but for the opposite direction (*enter the different hoop distances)*, for a total of 48 trials. A trial was considered correct when the beanbag fell into the hoop or was touching it. This allows us to estimate each participant’s throwing accuracy, as well to offer the participant awareness of their skill ability over the four difficulty levels. Participants then carried out a block of the throwing task, as detailed in experiment one, but this time with four, rather than three distances (insert). Participants carried out six trials for each distance, in a random order.

**Results**

All participants except one successfully managed to complete the *reaching* task. Do we exclude this participant from the analysis? What analysis? Results for the second session of the *throwing* task, for each participant, are shown in Figure 4. We can see that none of the participants managed to follow the optimal strategy, although some, such as 9 (in the Sudoku condition) and 13 and 18 (in the reaching condition) did come close.

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| Figure 4: Results for each individual in experiment 2. To prevent overlap, points have been jittered in the x-axis. |
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| Figure 5: Comparison between groups for Experiment 2. |

**DISCUSSION**

Initially these results were interpreted based on heuristic decision making; cognitive processing that, despite not evaluating all available information, offer immediate results (Clarke & Hunt, 2015). Participants more or less knew what their task was just after some trials, reducing cognitive demands. Heuristics save effort, but also suggest a larger amount of mistakes (Gigerenzer & Gaissmaier, 2011)and are used when there is no immediately clear way in accomplishing a given task or solving a problem. If participants used heuristics they did it, successfully, in order to limit evaluation of the situation, but did not obtain effective results. The throwing task in this study from the participant’s point of view was simple: to get the beanbag in its hoop. Factors like percentage correct, throwing or reaching ability, pattern of colours or distances of beanbags, competition and gains or losses were not being considered by them. To independently adjust behaviour from idiosyncratic reasoning to rational/logical reasoning is really difficult, which explains why in some conditions inferring using heuristics is demanded, and in others using optimization(Katsikopoulos, 2010). This study could consider ‘mental-laziness’ as a side effect of heuristics and axioms even before their evaluation, eliminating logical. Lack of knowledge, sensory information and cost/benefit calculations, which weigh uncertainty, are necessary, and when absent gamble valuable contribution to ideal decisions (Wolpert & Landy, 2012). This can partly explain why the unprimed participants failed to perform optimally, but does not give evidence for the lack of transfer of knowledge for the primed participants.

We constantly cope with improbability and modify our understandings and actions based on our subjective doubt, and available information. Therefore, our feeling of confidence in something is based/can be changed by how stable that something is (Gherman & Philiastides, 2015). Our participants were ignorant of our hypothesis and the study framework, parsing all details by their own reasoning processes. As everything in their perspective was random, this created a stable environment of chaos, increasing their confidence on performed strategies and ignoring feedback thereof.

The observation that primed participants also generally failed at the throwing task was surprising and unexpected. They repeatedly behaved against probabilities demonstrating a lack of reliability on their results. Theory building is inductive (Latham & Locke, 2007) working from observations and patterns up towards a theory; following a ‘bottom-up’ approach. Priming gave them a broader foundation to begin pattern detection and accomplish an optimal strategy but still failed. Humans don’t intuitively comprehend the idea of statistics and probabilities (Shermer, 2008), which explains participants initial ignorance when performing the throwing task. It fails though to reason why the majority of them neglected all information from the reaching task, and were stubborn to not relocate that knowledge over to the throwing task. Intelligence is flexible, influenced and developed by learning, alongside intuition which is sculpted automatically and individually with practice (**Gladwell**, ?), but still fails to resolve with our findings. This is not to say though that our results portray a human population lacking intelligence and intuition, as one task can’t be directly compared to the other. The throwing task demanded more handling of information in order to achieve optimality, but our participants could have had different priorities. If intuition is ineffective the next best bet is rational thinking (Covey, 1989). If our participants had weigh all options including a perceived probability on different possible standing positions (in relation to throwing accuracy), then they would be more optimal as task difficulty increased. Moreover, we would notice their strategy adapting across the trials.

During debriefing we asked our participants what they thought our objective was and while some remained baffled, others were looking for some colour pattern during the throwing task regardless being told that it was all completely random, just as in Clarke and Hunt (2015). Pattern recognition could be simpler for participants than being optimal since the former relies on external factors, while the latter signifies the individual being ‘at fault’. Intuitive actions also rely on pattern recognitions that have build-up from past experiences(Wilhelm & Baynes, 1950). These are subconscious, but ones that we know make sense and give reliable outcomes.

Another explanation for our results is that the transfer of receptive or comprehensions skills to productive skills could be biased or incomplete (O'Malley & Chamot, 1990). Understanding the objective task activates related, albeit unconscious, representations which should form a foundation of appropriate and optimal actions. To investigate whether this was, or wasn’t, the case we conducted the second part to the study, i.e. throwing-reaching-throwing task.