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Training Fast and Frugal Heuristics in Military Decision Making

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Abstract

Fast and frugal heuristics have been used to model decision making in applied domains very effectively, suggesting that they could be used to improve applied decision making. We developed a fast and frugal heuristic for infantry decisions using experts from the British Army. This was able to predict around 80% of their decisions using three cues. Next, we examined the benefits of learning to use the fast and frugal heuristic by training junior officers in the British Army to apply the heuristic and assessing their accuracy and mental workload when making decisions. Their performance was compared to a control condition of junior officers who applied standard military decision methods. Participants using the fast and frugal heuristic made decisions as accurately as participants in the control condition, but with reduced mental demand. This demonstrates that fast and frugal heuristics can be learnt, and are as effective as analytic decision methods.

Keywords: fast and frugal heuristics, decision making, mental workload

Training Fast and Frugal Heuristics in Military Decision Making

The difficulties with making good decisions in applied domains such as business, medicine, or the military are well established but far from resolved. Whilst influential models of decision making such as Subjective Expected Utility Theory provide optimal solutions to problems with known risks and tractable amounts of information (e.g. Edwards, 1954; von Neumann & Morgenstern, 1947), these conditions are typically not met in applied domains. In many applied domains relevant information is not known and the likelihoods of events cannot be reliably estimated (e.g. Simon, 1956). Situational constraints such as time pressure and stress may not allow decision makers time or capacity to process all of the relevant information (e.g. Orasnu & Connolly, 1993). One solution that has been proposed is that decision makers rely on heuristics instead of more computationally demanding optimal strategies. A common definition of a heuristic is a strategy that arrives at a satisfactory solution with a modest amount of computation (Simon, 1990). The advantage of using a heuristic is that it simplifies the process and reduces the effort involved in making a decision (Shah & Oppenheimer, 2008). A major concern with using heuristics in applied domains where decisions have significant outcomes follows from the considerable body of research demonstrating that heuristics can lead to biased thinking (e.g. Kahneman, Slovic, & Tversky, 1982). But more recently, a programme of research on fast and frugal heuristics has identified a number of heuristics that are not less accurate than complex strategies and may even be more accurate (e.g. Gigerenzer & Gaissmeier, 2011). The heuristics are fast in that they can be applied quickly and frugal in that they require only a small amount of information, often only two or three or sometimes fewer cues. There are a number of studies that use fast and frugal heuristics to describe decision making in applied domains (e.g. Dhami & Ayton, 2001; Smith & Gilhooly, 2006), but less is known about whether experienced decision makers can be trained to apply fast and frugal heuristics and the influence that this has on their decision making.

Learning to apply a fast and frugal heuristic is an important topic to investigate for two reasons. First, most previous research on fast and frugal heuristics in applied domains has demonstrated that the pattern of decisions made can be modelled with a fast and frugal heuristic. But this does not demonstrate that decision makers necessarily use this process, nor how well they can learn to use it. To assess how effectively the heuristics can be learnt and applied, this study will train decision makers to apply a fast and frugal heuristic in an applied domain and contrast it with the established decision method in that domain. Second, it is claimed that the simple structure of fast and frugal heuristics are intuitively plausible, fast, and simple to apply (e.g. Hafenbrädl, Waeger, Marewski, & Gigerenzer, 2016). But this has not been tested empirically in an applied domain. The aim of this study is to first develop a fast and frugal heuristic of expert decision making in an applied domain. Then to train less experienced decision makers, early in their career, to use the expert fast and frugal heuristic and test both the accuracy and mental workload involved in using it within a randomised controlled trial. The domain studied is military decision making – an area that requires training to support critical decision making in challenging environments (Shortland, Alison, & Moran, 2019).

Military Decision Making

Decision making in the military is taught formally as a sequence of analytic procedural steps. These have been developed from military experience and are embodied in military doctrine (Shortland et al., 2019). Although different nations have some unique variations, the common major steps are: clarifying the mission; assessing the situation; developing several courses of action; comparing the courses of action; selecting a course of action; developing orders (e.g. Bryant, Martin, Bandali, Rehak, Vokac, & Lamoureux; Matthews, 2014). The process is thorough, detailed and the emphasis is on applying a rigorous process of logical deduction to complex and ill-structured situations in order to develop a sound plan. However, in practice, there are circumstances when it is difficult to follow this process fully; for example, under time pressure (Matthews, 2014).

The Naturalistic Decision Making (NDM) programme of research developed to explain decision making in circumstances such as this. NDM is concerned with decisions made in real-world settings characterised by complexities such as ill-structured problems, time stress, and high stakes as opposed to artificial laboratory tasks (Orasnu & Connolly, 1993). It emphasises the expertise of decision makers rather than their biases (Kahneman & Klein, 2009). For example, Klein (1989) proposed that the majority of decisions are made by proficient decision makers using their experience to recognise the situation they are facing and recall the typical action for that situation. These ideas developed from work on chess expertise as a perceptual skill (e.g. Chase & Simon, 1973), and the insight was developed into a theory of recognition-primed decision making that has been applied in a range of domains including military decision making (Klein, 1993). To test this theory, Pascual and Henderson (1997) coded 60% of decision strategies used during a military command and control exercise as recognition-primed decision making, suggesting that it is much more common than the 2% of strategies that were coded as 'classical' decision making. Other NDM models have been developed that are better able to explain other aspects of decision making, such as the factors that can derail decision making (Shortland, Allison, & Barrett-Pink, 2018). New decision making procedures have been proposed that are more aligned with recognition-primed decision making (Ross, Klein, Thunholm, Schmitt, & Baxter, 2004), better suited to decision making under time pressure (Thunholm, 2005), or capitalising on intuitive thought (Bryant et al., 2007). For example, these methods begin with identifying a course of action that is subsequently refined, based on the insight that experts generate a good course of action upon recognising the situation, rather than generating several courses of action for evaluation only after rigorous analysis.

The programme of NDM research shares some fundamental concepts with research on fast and frugal heuristics (Keller, Cokely, Katsikopoulos, & Wegwarth, 2010; Shan & Yang, 2017). Both areas rejected the heuristics and biases programme which implied that people were irrational and flawed decision makers (Kahneman, Slovic, & Tversky, 1982). Instead they both argued that the tasks used in this area were removed from the environment to which people were adapted and by using more ecologically valid tasks demonstrated that people were competent decision makers (Gigerenzer, Hoffrage, & Kleinbölting, 1991; Klein, Calderwood, & Clinton-Cirocco, 1986; 2010). Both areas share a view of bounded rationality that is constrained by the environment and cognitive limitations rather than comparing people to an unbounded rational standard of decision making (Simon, 1955).

However, there are differences. Whilst recognition-primed decision making and fast and frugal models both describe responses to cues, typically recognition-primed decision making relies more on cues from experience and fast and frugal heuristics rely more on cues in the environment. Cognitive task analyses in NDM research typically suggests more cues are used to recognise a situation than in a fast and frugal heuristic (e.g. Kaempf, Klein, Thorsden, & Wolf, 1996). Fast and frugal heuristics are modelled more formally and with greater precision than NDM theories, but the majority of work has not focused on expert decision makers or taken place in real-world settings. Whilst NDM research on experts has enhanced the relevance of the models for proficient decision makers, it provides less support for inexperienced decision makers who have not yet acquired expertise. NDM models, and the dominant recognition-primed decision making model in particular, exploit the ability of experts to identify a good course of action as the first option generated. However, a decision making method based on this ability cannot be applied by less experienced decision makers who do not have this knowledge yet. How then are junior officers trained to make decisions? The current approach is to use the formal military decision making process that is a general purpose method that a less experienced decision maker can be trained to apply until sufficient expertise is acquired. But as we discuss above this process is difficult to implement under time pressure. We propose an alternative approach: using fast and frugal heuristics that do not require expertise to apply. If fast and frugal heuristics could be modelled on the decisions of experts, less experienced decision makers could be trained to apply them. This could enhance their decision making and offer a decision method that is well suited to naturalistic environments such as time pressure (the heuristics are fast) and limited information (the heuristics are frugal).

Fast and frugal heuristics in applied domains

The fast and frugal heuristics research programme has proposed a number of different heuristics (e.g. Gigerenzer & Brighton, 2009; Gigerenzer, Todd, & The ABC Research Group, 1999). Of these, one type of heuristic has been used most commonly to model the decision making of experienced decision makers in applied domains, namely fast and frugal trees (Martignon, Katskikopoulos, & Woike, 2008). This heuristic simplifies the decision by using only a small number of cues and integrates them using a non-compensatory process. The heuristic searches through the cues in order of validity and after each cue there is a binary outcome to either make a decision or continue the search. The first cue is assessed to test if a critical value is found. If it is, then a decision is made. If not, the heuristic moves to the second cue and repeats the process. This continues until the end of the tree. Typically fast and frugal trees have around two to four cues and have been tested in wide range of applied domains, including engineering (Cropp, Banks, & Elghali, 2011), medical decision making (Smith & Gilhooly, 2006), and legal decision making (Dhami, 2003; Dhami & Ayton, 2001). Fast and frugal trees predict the decisions of domain experts in these studies as well as regression models, despite using less information and simpler computation than the more complex regression models.

Having established that a fast and frugal heuristic can model the decisions made in applied domains very effectively, it is reasonable to propose that they should be used to improve applied decision making (Hafenbrädl, et al., 2016). For example, they have been proposed as a method of screening for clinical depression (Jenny, Pachur, Williams, Becker, Margraf, 2013). However, less is known about how effectively decision makers can actually learn and use fast and frugal heuristics. Despite good model fits, it is possible that decision makers are not actually using the heuristic but rather a different set of cues or process that correlates with the heuristic and therefore leads to the same outcome (Hilbig, 2010). A model fitting strategy cannot distinguish between two models that may vary greatly in process but have the same outcomes. To test how effectively the heuristic can be learnt and applied requires an experimental manipulation in which decision makers are trained to apply the heuristic, removing the possibility that the decisions are actually being driven by other cues or processes. There is little experimental evidence assessing how effective this is in applied domains. Green and Mehr (1997) speculate that decision makers adopt a fast and frugal tree following the introduction of a detailed probability chart, but they do not actually train or elicit the tree from participants and so this evidence is indirect. Snook, Taylor and Bennell (2004) instructed participants in the use of two heuristics that could be used to predict the location of criminals. The accuracy of their predictions significantly improved from a baseline measure taken prior to instruction. Whilst this demonstrates the ease with which this heuristic can be learnt and applied, it does not fully answer the question about the utility of training heuristics in applied domains. All of the participants in the study were novices with no experience in the domain. The study therefore demonstrates that knowing a heuristic is better than knowing nothing about the domain. But in applied domains decision makers will typically be trained and experienced in the domain and it is possible that compared to well-trained decision makers no additional benefit of fast and frugal heuristics will be found, or even that the heuristics are not as effective. Therefore the accuracy of applying a fast and frugal heuristic will be assessed to discover if it is more or less accurate than more complex decision methods used by well-trained decision makers.

As well as examining the accuracy of decisions made after learning a fast and frugal heuristic, we will also assess the ease of use in applied domains. Fast and frugal heuristics are commonly described as intuitively understandable, faster and less mentally demanding than more complex decision methods because they use less information (e.g. Dhami & Harries, 2001; Smith & Gilhooly, 2006) but this has rarely been empirically assessed. Therefore the workload required when applying a fast and frugal heuristic will be assessed to discover if it is more or less than that in more complex decision methods used by well-trained decision makers.

The Present Study

In this study, we aim to develop a fast and frugal heuristic of military decision making and then train less experienced decision makers to apply the expert fast and frugal heuristic to assess its utility in comparison to existing decision methods in an applied domain. This study focuses on Platoon Commanders' decisions in the infantry as they operate in complex, ambiguous environments where quick decision making is required in response to dynamic events on the ground. Platoon Commanders are typically junior officers responsible for three or four sections, each of which is comprised of a small group of soldiers. Their decision making will be assessed using a set of scenarios that describe typical situations they face. First, highly experienced decision makers will make decisions about the best course of action in each scenario. A fast and frugal heuristic will be modelled on these responses. Then, less experienced decision makers will be trained to apply the expert fast and frugal heuristic. These decision makers are not novices, they are Officer Cadets and junior officers in the British Army. They have been extensively trained in the standard decision method used in the British Army during their first year of training both in the classroom and in the field, and those specialising in the infantry complete further training. However, they have not yet acquired the level of expertise assumed by NDM models such as recognition-primed decision making. To be of practical value, a fast and frugal heuristic must have a benefit over existing decision methods. Therefore assessing the value of a fast and frugal heuristic in this sample provides a strong test of its value in applied domains as the participants are already well trained and knowledgeable about the task.

Participants will complete one set of scenarios before training in the fast and frugal heuristic and one set after training. The decisions will be compared to the expert response as a measure of decision accuracy. Participants will also complete the NASA-TLX (Hart & Staveland, 1988) to assess the workload involved in making the decisions at pre and post-test. A control group will complete the same decision scenarios and workload measure without training.

Studies evaluating fast and frugal trees in applied domains have compared their accuracy to another more complex model such as a regression model. Typically they have performed comparably (e.g. Dhami, 2003; Smith & Gilhooly, 2006). However, no study has directly compared participants trained to use a fast and frugal tree to participants trained in using the established methods within that applied domain. But given the claims made for the accuracy of fast and frugal heuristics, we hypothesise that participants in the training group will either improve or maintain their decision accuracy. A clearer prediction can be made concerning the workload. A defining feature of fast and frugal heuristics is that they are fast to apply and require less information and processing than other decision methods. In contrast, the standard decision method used in the British Army is designed to be comprehensive and analytic. Therefore we hypothesise that participants in the training group will rate the fast and frugal heuristic as requiring less mental workload than the control group. In particular, the mental demand required to apply the heuristic will be less than the standard decision method, as reducing mental demand is key function of heuristics (Shah & Oppenheimer, 2008).

Development of the Fast and Frugal Heuristic

To construct the fast and frugal heuristic, the method used by Neth, Czienskowski, Schooler, & Gluck (2013) was applied. A range of scenarios were constructed in order to elicit a series of decisions. The scenarios concerned a typical task for platoon commander – securing a road junction in order to allow safe passage of a convoy. The set of potentially important factors in the Platoon Commanders' decision was generated from the training materials used and from subject matter experts. From these, a set of scenarios was generated that systematically manipulated these cues. It is important to note that an experimental task of this nature cannot fully replicate the complexity of operational decisions. Nonetheless, to ensure ecological validity was maximised as far as possible, the materials used in the study were developed with an emphasis on the importance of representative design (Dhami, Hertwig, & Hoffrage, 2004). The scenarios were developed with a subject matter expert and presented in the format typical for receiving a mission briefing with all the relevant information, typical language, abbreviations etc. that would be used in a briefing, along with a map. Experts made decisions about the correct course of action in each scenario. Multiple regression was used to elicit the weighting of each cue in their decision. This provided the sequential order of the importance of each cue. The expert heuristic was then constructed by examining how well the cues classify expert decisions, starting with the most highly weighted cue and adding cues sequentially until adding additional cues no longer improved the accuracy of the classification of the expert heuristic.

Method

Participants

Six expert participants took part in the development of the fast and frugal heuristic. They were trainers at the Infantry Battle School, delivering the training for Platoon Commanders.

Design

A factorial survey approach was used to investigate the relationship between different decision making cues within typical scenarios for Platoon Commanders and judgements about the correct course of action in those scenarios.

Materials

First, the most important cues in infantry decision making were identified through a review of the decision training materials for platoon commanders and through consultation with a subject matter expert, an experienced former Army officer. Fourteen key cues were selected through this process, e.g. enemy strength. The cue values for each were coded as either positive or negative, e.g. the enemy was either strong or weak. A set of thirty-two scenarios was created using a fractional factorial design. This approach generates the minimal number of scenarios using an orthogonal design. This means that each cue is uncorrelated with the others so that the contribution of each to the overall judgement can be calculated. These were reviewed by the subject matter expert to ensure that all scenarios were plausible (Stewart, 1988). The subject matter expert then developed a sequence of related scenarios concerning a typical task for platoon commander – to secure a road junction in order to allow safe passage of a convoy. The scenario contained information about each of the thirty-two variations of this scenario systematically manipulated the cues according to the fractional factorial design. For example, in the first scenario the enemy were weaker (reports indicate two or three gunmen), visibility is poor (due to early morning mist), whereas in other scenarios the enemy were stronger (reports indicate at least ten gunmen) etc. Participants then rated the extent to which they thought four possible courses of action were correct for each scenario. The courses of action were: attack; defend; withdraw; call upon external fire power. These were rated on a six point Likert scale from 1 = 'Definitely incorrect' to 6 = 'Definitely correct'.

Procedure

The survey was conducted using paper and pencil. The order of the scenarios was individually randomised. There were no time limits, but it took approximately forty-five minutes to complete.

Results

The fast and frugal heuristic was developed in three steps. First, the weighting of each cue in each of the experts' decisions was calculated using multiple regression. Each of the cues within the cases was coded as an independent variable and the decisions made about each scenario (attack, defend, withdraw, support) were the dependent variables. Each of the four decisions was modelled with a separate multiple regression. The R^2 value for the regression model describes how well the factors explain the decision made and the standardised beta weights for each cue describe the weighting of that cue in the decision. From this, the cues were ordered based on how influential they were in the decisions.

In the second step of the process, the expert heuristic was developed by finding the minimum number of cues that could effectively classify the experts' decisions. The mean expert decisions for each scenario were recoded from a six point scale into three categories: 'Strong' (6.00 - 4.50); 'Medium' (4.49 - 2.50); and 'Weak' (2.49 – 1.00) indicating how strongly they would select that course of action. The most highly weighted cue was selected and the modal expert response calculated for each value of the cue. For example, in decisions to attack the most highly weighted cue was 'Own approach'. This has two values: 'good' and 'poor'. The modal expert response for 'Own approach: Good' was 'Strong attack' and the modal response for 'Own approach: Poor' was 'Medium attack'. Then, the next most highly weighted cue was added and the percentage of expert decisions correctly classified is calculated. Cues were added until further additions no longer greatly improved the fit of the heuristic to the expert decisions or they excessively increased the complexity of the heuristic. This process was applied to all four decisions to create a fast and frugal heuristic for each.

The final step was to integrate four individual heuristics into one heuristic that provides a good basis for all of the decisions whilst retaining a simple structure. In order to incorporate all of these heuristics into a single heuristic, only three cues are required: own approach; enemy strength; and civilians. These cues classify the experts' decisions optimally in all four decisions. Table 1 presents the percentage of correctly classified expert decisions for each heuristic. Therefore these three cues were combined into a single integrated heuristic for all decisions. The order of the cues does not affect the number of decisions correctly classified. They were placed in an order reflecting the importance of cues across all the decisions: own approach + enemy strength + civilians. The modal expert decision for each of the four decisions was then linked to this heuristic. The overall fast and frugal heuristic that combines these four heuristics and is presented in Figure 1. This fast and frugal heuristic predicts approximately 80% of decisions made by the experts using only three cues.

Testing the Fast and Frugal Heuristic

Method

The study protocol was approved by the Ministry of Defence Research Ethics Committee. Data are not available for sharing due to confidentiality.

Participants

Fifty-eight participants took part in the study, mean age = 24.10, SD = 2.13. Participants had been in the Army for a mean of 1.49 years, SD = 1.15. No participants had operational experience.

Design

A 2x2 mixed factorial, randomised controlled trial design was used. Participants were randomly allocated to either the training condition or the control condition. All the participants completed all of the measures at two time points, Time 1 and Time 2. Participants in the training condition completed the measures at Time 1 before training and at Time 2 after training. Participants in the control condition completed the measures at Time 1 and then the measures at Time 2, without training.

Materials

Decision task. The decision task was constructed by selecting six of the thirty-two scenarios created in order to develop the fast and frugal heuristic. Scenarios were selected so that they covered a range of responses. The six scenarios were divided into two sets of three that were similar but not the same. One set was completed at Time 1 and the other at Time 2. As for the development of the heuristic, participants rated the effectiveness of four courses of action for each scenario: attack, defend, withdraw, call upon external firepower. Each course of action was rated on six point scale from 'Definitely incorrect' to 'Definitely correct'. Accuracy was assessed by calculating the difference between participants' ratings and the mean expert ratings.

Subjective workload. Subjective workload was assessed using the NASA-TLX (Hart & Staveland, 1998). This is comprised of six scales assessing different elements of workload of which four are relevant to this study: mental demand; temporal demand; performance; and effort. Participants rate the level of demand on a twenty point scale from 'Very low' to 'Very high'.

Procedure

After an initial introduction to the purpose of the training and consenting to participate, participants were randomly allocated to the training or control condition. Demographic information was collected then participants in both conditions completed the first set of three decision making scenarios and rated their workload using the NASA-TLX. This was the baseline condition, Time 1. Participants in the control condition then completed the second set of three decision making scenarios and rated their workload using the NASA-TLX whilst participants in the training condition took a short break. Next, participants in the training condition attended a training session on using the fast and frugal heuristics to make decisions. Participants in the control condition were offered the opportunity to attend this training alongside them. Training lasted approximately two hours and was designed to motivate participants to engage in the training, explain the fast and frugal heuristic to them, and help them to learn it. To do this, the session began with a discussion on the psychology of expert decision making including findings that experts may use less information than novices (Shanteau, 1992). We explained how our fast and frugal heuristic was developed based on subject matter experts. We then introduced the heuristic for each of the four decisions (attack, defend, withdraw, and support). We summarised this heuristic again and encouraged participants to commit it to memory. Participants completed a practice problem with feedback. Participants in the training condition then completed three more decision scenarios and rated their workload using the NASA-TLX. This was Time 2. Participants did not have access to a copy of the heuristic when making these decisions.

Results

Decision Task Performance

Decision accuracy was calculated by subtracting the participants' response from the mean expert response. This creates a difference score in which a lower value indicates a response closer to the expert solution and is interpreted as a more accurate response. Table 2 presents the scores for each decision (attack, defend, withdraw, support) and the mean of all difference scores. For all the decisions, the Time 1 score was entered as a covariate into an ANCOVA and the Time 2 score was compared between the Training and Control conditions (Lord, 1967)For decisions to attack, there was no difference between the Training and Control conditions at Time 2 $F(1,54) = 2.73$, $p = .10$, $\eta_p^2 = .05$. For decisions to defend, there was no difference between the Training and Control conditions at Time 2 $F(1,54) = 1.84$, $p = .18$, $\eta_p^2 = .03$. For decisions to withdraw, there was no difference between the Training and Control conditions at Time 2 $F(1,54) = 0.97$, $p = .33$, $\eta_p^2 = .02$. For decisions to use external support, there was no difference between the Training and Control conditions at Time 2 $F(1,54) = 0.56$, $p = .46$, $\eta_p^2 = .01$. In the overall score, there was no difference between the Training and Control conditions at Time 2 $F(1,54) = 1.10$, $p = .30$, $\eta_p^2 = .02$. Overall, these results indicate that making decisions by applying the heuristic decision method leads to decision accuracy that is similar to decisions based on existing training.

Mental Workload

Mental workload was measured using four scales of the NASA-TLX: mental demand; temporal demand; performance; effort; and an overall mean score. Figure 2 presents these scores for each condition. For all the scales, the Time 1 score was entered as a covariate into an ANCOVA and the Time 2 score was compared between the Training and Control conditions. Mental demand was lower in the Training condition than in the Control condition. $F(1,52) = 4.07, p = .049, \eta_p^2 = .07$. There was no difference in temporal demand between the Training and the Control condition $F(1,52) = 1.10, p = .30, \eta_p^2 = .02$. There was no difference in performance between the Training and the Control condition $F(1,52) = 0.38, p = .54, \eta_p^2 = .01$. There was no difference in effort between the Training and the Control condition $F(1,52) = 0.003, p = .96, \eta_p^2 = .00$. There was no difference in overall workload between the Training and the Control condition $F(1,52) = 0.69, p = .41, \eta_p^2 = .01$. Overall, this indicates that making decisions by applying the heuristic decision method is less mentally demanding than making decisions based on existing training, and is similar in terms of temporal demands, effort, performance and overall workload.

Discussion

The aim of this study was to develop a fast and frugal heuristic of infantry decision making in experts and then to assess the effectiveness of less experienced decision makers in learning to apply the expert fast and frugal heuristics compared to current decision methods used by trained military personnel in the British Army. We created a fast and frugal tree that was able to predict around 80%

of their decisions using three cues. After training, we found that decisions made by less experienced decision makers using the fast and frugal heuristic were comparable in accuracy to those made using the standard decision method on which they were highly trained. There were no differences in overall workload between the decision methods. However mental demand, the key indicator of the mental workload involved in using the fast and frugal heuristic, was lower in the group trained to use the fast and frugal heuristic than in the control condition. Therefore participants using the fast and frugal heuristic were able to make decisions as accurately as in the control condition, but with less mental demand.

Implications for Fast and Frugal Heuristics

The comparable accuracy of the fast and frugal heuristic to the established decision method supports the broad claims made for the effectiveness of fast and frugal heuristics and extends this to an applied domain. After only a short training session in applying the fast and frugal heuristic, participants applying it in a realistic exercise made decisions as effectively as a control condition applying standard military decision making methods on which they had been trained. This supports the findings of previous research in fast and frugal heuristics which have been found to be as effective as more complex decision methods. It also adds to these findings by demonstrating comparability with well-trained decision makers rather than a mathematical model. Prior research has typically compared performance to an appropriate mathematical model such as linear regression (e.g. Smith & Gilhooly, 2006). Sometimes a mathematical model is chosen that is used in the applied domain, e.g. geographic profiling (Snook et al., 2004) but in most cases the mathematical model is not used in practice, its purpose is to provide a benchmark. But from an applied point of view, the most relevant benchmark is the current decision method applied by well-trained personnel so it is an important finding that participants' perform comparably with those using the current decision method. This demonstrates the practical value of the heuristic in an applied domain. As the current military decision method is comprehensive, thorough and analytic, it also supports the more general finding of research on fast and frugal heuristics that a simple heuristic can be as effective as a more complex, analytic technique.

A common explanation for the use of heuristics is the trade-off between accuracy and effort (e.g. Payne, Bettman, & Johnson, 1993). This means that a heuristic reduces effort but at the cost of reduced accuracy. However in this study accuracy was not reduced, but mental effort was. The benefit of the fast and frugal heuristic was not the result of an accuracy-effort trade-off. Instead it is likely that the reduced set of cues and simpler binary analysis of those cues were less effortful than the established analytic procedure, but the ecological validity of the heuristic maintained decision accuracy. The heuristic was therefore frugal. But it was not rated as fast. The temporal demand of the heuristic was the same as the analytic procedure. This may well be because the analytic procedure was highly trained whereas the heuristic was novel and that with further training the heuristic would become faster (Anderson, 1987; Logan, 1988). But nonetheless it is a feature of applied domains that apparently complex analytic processes that would be time consuming for a novice to apply are highly practiced and therefore are quick for an experienced decision maker. Complex yet fast decision making is commonly reported in the field of naturalistic decision making (Klein, et al., 1986; 2010). Alternatively, experimental research has shown heuristics may be fast or frugal but not both with the balance between these attributes determined by details of the underlying cognitive mechanism (Bobadilla-Suarez & Love, 2018). This particular heuristic may favour frugality. Overall, the major benefit of fast and frugal heuristics to trained decision makers is likely to be the frugality rather than the speed. Whilst this study took place in a classroom setting where there were few competing mental demands, this is often not the case in applied domains. The military personnel that participated in this study will be called upon to make decisions under considerable demands such as time pressure and stress that reduce working memory capacity and the ability to process information (Janis & Mann, 1977; Oei, Everaerd, Elzinga, Van Well, & Bermond, 2006). Under these circumstances applying a complex decision method could become problematic and an effective fast and frugal heuristic that requires a lower mental workload is likely to be of practical benefit.

In terms of accuracy and mental demand, the fast and frugal heuristic decision method performs well. But it should be noted that there are other criteria in applied domains that are less frequently used to evaluate fast and frugal heuristics. For example, Dhami (2003) comments that in some regards the fast and frugal heuristic applied in the courtroom operated contrary to the ideals of legal due process. Durand, Wegwarth, Boivin, and Elwyn (2012) constructed and compared decision aids for pregnant women choosing whether to take an amniocentesis test based on fast and frugal heuristics. The findings were complex as the evaluation of the heuristic was partially obscured by issues such as the usability of the actual implementation and the small sample size, but some women found the approach beneficial whereas others were concerned that the heuristic did not capture the emotional aspects of the decision (a possible outcome of the decision is elective pregnancy termination). For some users, irrespective of the accuracy of the heuristic, the whole approach may not be appropriate for the complex and emotional decisions faced in this applied domain. In the domain of forensic science, Rossmo (2005) question the application of fast and frugal heuristics to the reality of criminal investigation in part because of the serious consequences of decisions made using the heuristic. Is it acceptable that decision makers in applied domains are trained to ignore most of the information that is available to them? The accuracy of fast and frugal heuristics in modelling applied decisions is only one aspect to consider. Ethical, legal, professional and other considerations are also relevant in many applied domains and should be considered in future research and applications, in particular specifying when it is appropriate to use a fast and frugal heuristic and when a more comprehensive decision process is required. It is more likely that a fast and frugal heuristic would complement an existing decision process as an additional tool rather than replace it.

Implications for Military Decision Making

In comparison to the thorough and rigorous formal decision process that is trained in the military, it is surprising that the fast and frugal heuristic developed here, which only uses three pieces of information and combines them in a simple, binary fashion, leads to a comparable level of decision accuracy. This contrasts with the underlying assumption of the military decision making process that a comprehensive analysis of the problem is required in order to reach the best decision, but it is consistent with a common finding in research on fast and frugal heuristics.

The finding that decisions can be made just as effectively as with a formal decision making process but without extensive analysis is compatible with NDM research on military decision making such as recognition-primed decision making. A difference lies in the smaller number of cues used to determine the decision in a fast and frugal heuristic compared to recognition-primed decision making and the formal modelling which identifies specific cues to attend to and how to combine them. This creates an explicit model that can be trained directly and contrasts with the more general prescription to develop expertise e.g. through repeating tactical decision games to simulate relevant decisions leading to the relevant tacit knowledge that, as is common in expertise, is harder to pin down (Klein, 2015). Eliciting the expert fast and frugal heuristics may accelerate the process of learning them.

However, do experts use fast and frugal heuristics without explicit training? As was discussed in the introduction, the method applied here modelled expert decision making as a fast and frugal tree based on their choices in a set of decision scenarios. An advantage of this method is that cues are embedded within the scenarios and participants do not explicitly report which cues they use. Instead, the design of the scenarios means that the most influential cues can be inferred from their choices reducing the possibility of subjective bias in identifying cues. But it is possible that they were using a different strategy that led to the same outcome. Hence, the 'expert' fast and frugal heuristic may not in fact be the same process that experts were using. Further research is required to establish how well this heuristic reflects their actual decision process. However, this does not undermine the benefits found for less experienced decision makers when they were trained to apply the heuristic.

The training was conducted on a sample Officer Cadets and junior officers who do not have the extensive experience to apply recognition-primed decision making or other expertise-based approaches. Hence learning to apply a fast and frugal heuristic was a useful approach to assess. However, to what extent can these findings be generalised to a more experienced sample? The heuristic could be less effective with a more experienced sample who rely more on their knowledge to guide their decisions. But in other domains experts' choices were predicted better than novices by a fast and frugal heuristic (Garcia-Retamero & Dhami, 2009), suggesting that this approach may be applicable to more experienced decision makers too. Furthermore, given the range of situations and operations faced by contemporary military personnel, it is increasingly likely that a situation may be encountered which experienced decision makers have not previously experienced and so are not able to draw upon their knowledge the situation (Shortland et al., 2018). In this case, expert decision makers could benefit from fast and frugal heuristics of key factors to inform their decisions.

Many studies of fast and frugal heuristics test heuristics that have been acquired through experience in the environment (Gigerenzer & Gaissmaier, 2011). The cues within the heuristic are learnt adaptively as they are the most ecologically valid and a range of simple heuristics are developed for different situations. In contrast, the fast and frugal heuristic in this study was elicited from experts and trained explicitly rather than acquired through experience. A consequence of this is that it applies the cues used by experts when making decisions in the situations used to elicit the heuristic. Therefore this heuristic is not a general decision making method, but appropriate for the specific set of situations on which it was developed. A wider set of fast and frugal heuristics would be required to cover different types of scenario that might be encountered. Further research would be required to assess the range of fast and frugal heuristics required for expertise in a given role and to discover how extensive the number of expert fast and frugal heuristics is. This could be a large number, or alternatively it is possible that the majority of common scenarios could be addressed with a limited set of fast and frugal heuristics.

Limitations

A limitation of the fast and frugal heuristic studied here, and of many fast and frugal heuristics in applied domains, is the simple nature of the decision outcome. The heuristic quickly leads to a decision to attack, defend, withdraw etc. but then further decisions are required following from this. Having decided to attack, is the attack on the left flank or the right flank? Many applied decisions have this complexity. For example a medical decision to prescribe a drug or not is often not taken in isolation, but as part of an overall careplan with several interacting treatments. The heuristic also was developed around specific decision scenarios, but it would not be useful in every situation. More heuristics would need to be developed to cover more situations and further research is required specify how more complex multifaceted decisions unfold from simple heuristics.

A second limitation of this study was the method of implementing pre and post measures. Testing was considerably constrained by the availability of the participants. Ideally, the control condition would have completed the premeasure at Time 1 then engaged in a filler task whilst the training condition were trained and then completed the post measure at Time 2. However, the trainers managing the trainees did not want half of the trainees to receive training and the other half not. There was also a limited time slot to run the trial – the training could not be repeated. Therefore, a compromise was used in which the control condition completed both Time 1 and Time 2 measures prior to training. As a result, they had less time between completing the measures than the training condition. One concern is that this could have led to fatigue or reduced engagement in the control condition in the second set of problems because of the repetition of completing two sets in a row. Another possibility is that participants in the training condition could have been motivated by the training event and engage more in the task at Time 2. However, despite these potential problems, there was no difference in effort between the control and training conditions at Time 2 suggesting that motivation to exert effort was not adversely impacted by the nature of the control condition.

The military sample is unusual in that they are taught a prescribed military decision making method that is applied across a wide range of situations. Decision makers in other domains do not use this decision making process. However, the findings are of potential to relevance to other applied domains. Fast and frugal heuristics have been used to model decision making in areas of professional decision making such as medicine and law. If the heuristics can model those decisions, the possibility is raised that decision makers could be trained to use those heuristics too. Further research is required to evaluate the benefit of doing so across different applied domains.

The aim of the study was to contrast the effectiveness of decisions made using the fast and frugal heuristic with those made by participants trained to apply the established decision making process. However, it is important to note that comparison with the control group does not provide an absolute measure of effectiveness. The study only shows a measure of relative effectiveness by comparing decision accuracy between the two conditions. Furthermore, it is not certain what decision process was used by the control group and to what extent they fully and accurately applied the military decision making process. Nonetheless, this is a relevant comparison to make as it allows a contrast with how decisions are actually being made by this group.

Finally, although the task simulated the format of a mission briefing, the context and environment of the study differed from those encountered in an operational setting which would be more complex. Further research is required to understand how these factors would influence the use of fast and frugal heuristics.

Conclusion

Previous research has demonstrated that fast and frugal heuristics can be used to model decision making in applied domains, raising the possibility that they could be as effective as more complex decision methods. The current study showed this to be the case. A fast and frugal heuristic was developed that provided a good fit to expert decision making using only a small number of cues combined in a simple manner. Participants trained to apply this fast and frugal heuristic performed as well on a decision task as participants who had been extensively trained to apply an established decision method, but with less mental demand. This demonstrates that fast and frugal heuristics can be of practical value to well-trained decision makers in applied domains.

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Table 1: Optimal heuristics for the four decisions

Decision	Attack	Defend	Withdraw	Support
Heuristic	own approach + enemy strength	enemy strength + civilians + own approach	own approach + civilians	civilians
%ge of correctly classified expert decision	78%	78%	78%	97%

Table 2: Decision accuracy as a function of time and training condition

	Training				Control			
	Time 1		Time 2		Time 1		Time 2	
	M	SD	M	SD	M	SD	M	SD
Attack	0.84	0.38	0.70	0.29	0.87	0.35	0.82	0.31
Defend	1.18	0.59	0.96	0.48	1.18	0.42	1.10	0.34
Withdraw	1.08	0.52	1.02	0.44	1.18	0.39	1.16	0.38
Support	1.28	0.61	1.24	0.51	1.30	0.63	1.16	0.59
Overall	1.09	0.33	0.98	0.30	1.13	0.27	1.06	0.22

N.B. Lower numbers indicate greater accuracy / less deviation from expert responses.

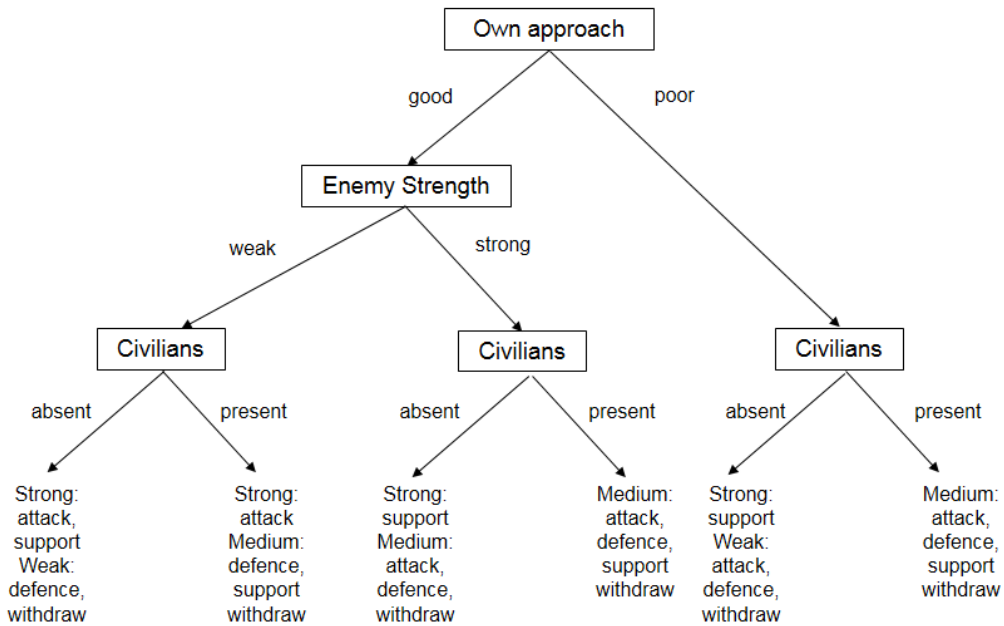

Figure 1: Fast and frugal tree for infantry decisions

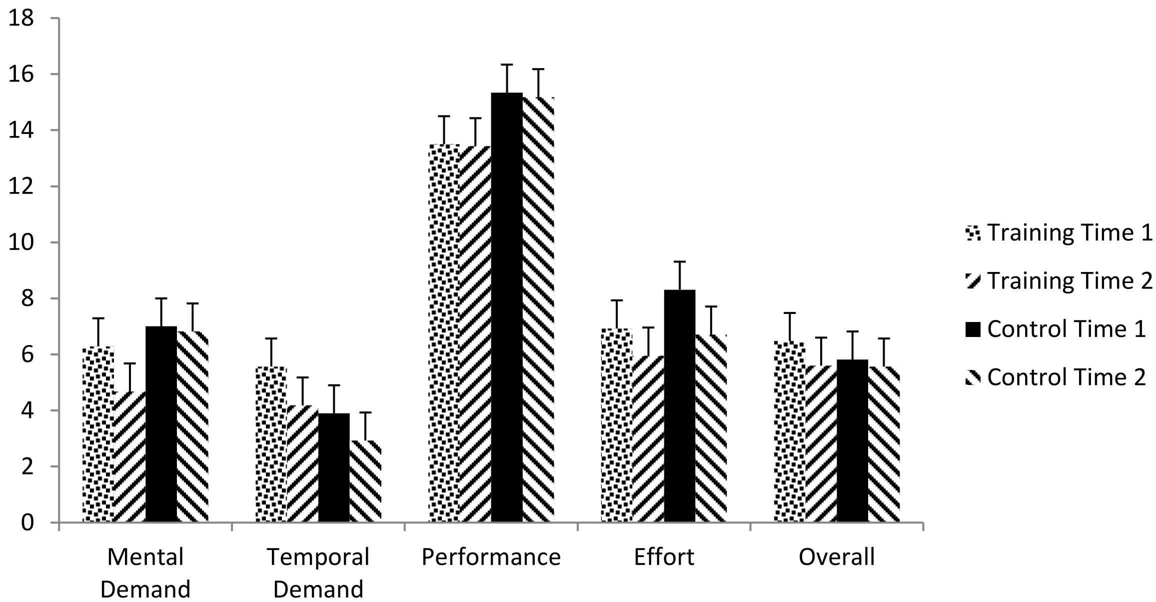

Figure 2: Mental workload as a function of Time and Training condition