The Effects of Pressure on Strategy Selection for Decisions Made Under Uncertainty

by

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Abstract

Decisions are often made in high-stakes or pressure filled situations. Some evidence suggests that in the presence of social and performance pressures, some people become less able to maintain the use of complex strategies (Beilock & Carr, 2005; Copeland & Radvansky, 2004). In the current study a movie judgment task was used to assess transitions in strategy selection under social and performance pressures. No evidence of changes in decision strategy was found. However, participants who were not given explicit strategy training were, in general, slower to make decisions in pressure and no pressure conditions. These findings indicate that under pressure people are generally able to maintain complex strategy use, but without training for a particular strategy, they may need more time to determine which strategy is appropriate for a decision.

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People often have to make decisions when outcomes are uncertain in high-stakes environments. Business leaders must often decide if a new project will be profitable and a good use of company resources. In many cases poor decisions can severely reduce a company's profitability. For example, in the entertainment industry, recent decisions to make films such "R.I.P.D" and the "Lone Ranger" have resulted in estimated losses of nearly $100 million per film. Decisions such as these are made daily, thus it is important to examine the impact of pressure on decisions made under uncertainty.

Recent evidence suggests that when people have access to information that is predictive of desirable outcomes, they tend to rely on strategies that incorporate multiple pieces of relevant information (Bröder & Schiffer, 2000; Newell & Shanks, 2003). For example, when evaluating the best car to purchase, most people tend incorporate various attributes (i.e., gas mileage, model year, reliability, etc.) into their decision process.

Generally, people will often rely on more complex decision strategies that incorporate multiple pieces of information under ideal conditions, but when they are subject to greater demands such as cognitive load or time pressure, they tend to shift towards simpler strategies in lieu of complex ones. Some authors have argued that in high-pressure environments, where optimal performance is at a premium, distracting thoughts and worries can consume resources that would have normally been devoted to solving the task at hand (Gimmig, Huguet, Caverni, & Cury, 2006). When people use decision strategies that are cognitively demanding (i.e., that incorporate multiple pieces of information), these strategies may be difficult to implement in high-pressure environments. Given that many decisions are often made under less than ideal conditions, it is important to understand how decision strategies can change in the presence of a stressor. Therefore, the purpose of this study is to examine the impact of social and performance pressures on strategy selection for decisions made under uncertainty and whether people who are trained to use a specific strategy will shift to a different strategy in a high-pressure situation.

Strategy Selection

Various strategies can be implemented to make a choice between options that have multiple attributes (Busemeyer, 1985; Klein, 1983; Payne, Bettman, & Johnson, 1988). Typically, a decision maker will make a choice based on some knowledge they possess about their options. As an example, a person could be asked, “Which city has a larger population: Louisville or Milwaukee?”. This question can be answered by using a variety of strategies: A person could choose the city that is more familiar to them or attempt to come up with specific reasons one city is larger than the other city. Someone could select Milwaukee over Louisville simply because they know professional sports teams tend have franchises in larger cities and Milwaukee has multiple professional sports teams. If a person knows a great deal of information about each city, they could make a decision based on combined predictive information such as the presence of a large airport and the fact that one of the cities has a national university. Generally, decision strategies can be divided in to two broad categories: 1) one-reason strategies, and 2) weight-of-evidence strategies.

One-Reason Decision Making

One of the simplest strategies one can use is a one-reason decision strategy. The Take-The-Best heuristic (TTB), a specific one-reason strategy, is considered to be a simple strategy that is both fast and frugal with regard to the demands it places on the decision maker, and because it can be implemented by using only one piece of information (Gigerenzer & Goldstein, 1996). When using TTB, the decision maker first determines whether or not they recognize either option. For example, if the person recognizes one city but not the other, they will choose the city that is recognized. When both cities are recognized, the decision maker must begin to search memory for information or “cues” that are predictive of the correct answer. According to Gigerenzer and Todd (1999), people attempt to search for the cue with the highest predictive validity. A concrete example of this strategy is provided in Figure 1. The table presents two movie options (A and B) with different cues (budget, star power, rating, and original screen play). Each option is presented along with cues that can be either present or absent. A plus sign (+) indicates the presence of a cue and a negative sign (-) indicates absence of the cue. Each cue is associated with a predictive validity (noted above the cue in the figure). In this example, a movie with a “big budget” (a budget over $100 million) accurately predicts the movie that grossed more money at the box office 80% of the time and is the best single predictor of box office earnings. Because this cue also discriminates between Movies A and B (i.e., the cue value is positive for Movie A and negative for Movie B), someone using a TTB strategy would ignore all other cue values and predictive validities and would thus select Movie A.

Proponents of the TTB heuristic argue that it is a plausible explanation of human decision making because it requires minimal effort while producing accurate inferences. TTB requires minimal effort because decisions can be made quickly by using recognition or by searching for only one piece of information. Gigerenzer and Goldstein (1999) have demonstrated that in spite of its simplicity, TTB can produce accurate inferences relative to more complex strategies). Compared to multiple regression, where all possible cues can be combined to predict outcomes, TTB was shown to predict correct inferences 75 percent of the time whereas multiple regression predicted the correct choice 77 percent of the time across a wide range of decision environments.

Given that TTB requires considerably less effort than a multiple regression approach while still producing accurate inferences, it seems likely to be a viable strategy in many environments.

More recently, researchers have moved beyond assessing TTB in terms of its ability to produce accurate inferences and have begun to assess whether or not people actually use this strategy. In several experiments, Bröder (2000) used a diagnostic method to determine the frequency of use for TTB. Participants learned cues associated with several options and were later asked to make predictions based on the information they had learned. When using TTB, people produce inferences using only a single cue. Therefore, TTB should be used more often in environments where there are large differences between the predictive validities of cues. Across two separate experiments, approximately one quarter of participants were classified as making decisions consistent with TTB. As predicted, use of the TTB heuristic increased when there were large differences between the predictive validities of cues, indicating that people are somewhat sensitive to decision environments where TTB is a more accurate strategy. Additionally, Bröder (2000) found that a majority of participants used TTB when there was a cost associated with accessing additional information. More specifically, Bröder (2000) manipulated acquisition cost in a literal fashion by forcing participants to pay fictional monetary amounts to acquire predictive information.

Researchers have also increased cognitive load and used time pressure in order to manipulate the cost and effort associated with different strategies. Reiskamp and Hoffrage (2008) found that people were more likely to use one-reason decision strategies while under severe time pressure. Bröder and Schiffer (2006) examined use of TTB under several cognitive load conditions and demonstrated that participants were more likely to rely on TTB, however, when no cognitive load was present, participants were more likely to be classified as using more complex strategies that combined multiple pieces of information. In sum, a consistent finding is that people are much more likely to use one-reason decision strategie when the cost associated with combining multiple pieces of information is high.

Figure 1. Here, there are two options with four different cues with varying predictive validities. Using a one-reason decision strategy, Movie A should be selected because it has a positive cue value for the most predictive cue (Big Budget). Movie B should be selected when using a weight of evidence strategy because its weighted sum total of all four cues is greater (1.8>.8). Further, if people use an equal weight rule, Movie B should be selected because it has positive cue values for three cues whereas Movie A only has a one positive cue value.

	.8	*.7*	*.6*	*.5*	
	Budget	*Stars*	*Rating*	*Original*	*wSUM*
Movie A	+	–	–	–	.8
Movie B	–	+	+	+	1.8

Weight-of-Evidence Strategies

Because people tend to shift towards one-reason decision strategies when information acquisition costs are high, several authors have argued that weight-of-evidence strategies must be the preferred strategy. That is, when people have sufficient cognitive or environmental resources available, they prefer to use more information to make decisions (Newell, Weston, & Shanks, 2003). Two of the more commonly examined weight-of-evidence strategies are the weighted additive rule (WADD) and the equal weight rule (EQW). WADD takes all relevant information into account. For example, in Figure 1, each piece of relevant information is weighted according to its predictive validity and is combined to yield a total sum and then the option with the largest total sum is selected which in this case would be Movie B (recall that one-reason decision making would lead one to choose Movie A). Similarly, the EQW also utilizes each piece information, but instead of weighting each cue according to its predictive value, it treats all cues as though they are equally predictive. Again, Movie B would be selected using the EQW strategy. Thus, EQW can be a highly accurate strategy even though it requires considerably less effort than WADD (Thorngate, 1980).

Using a stock market task, Newell and Shanks (2003) examined the likelihood that people would rely on multiple pieces of information to make decisions. During a learning phase, participants were provided with options and their corresponding predictive cues. Once participants were familiar with each option and its associated cues, they were asked to choose the best stock option. In one experiment, cue values (i.e., the presence or absence of each cue) were occluded until participants purchased the information. If participants only relied on a one-reason decision strategy, then they should discontinue searching for additional information once they had uncovered the most predictive discriminating cue. However, most participants continued to purchase at least one additional piece of information after the option with the more predictive cue had been revealed. The authors concluded that most decision makers preferred to use additional information beyond one reason even when the one reason is the most predictive. Similarly, Bröder and Gaissmaier (2007) examined WADD and EQW strategy use across five separate experiments and found that 41% of decision makers could be classified as using multiple cues to make their decisions. The authors observed that people were most likely to use weight-of-evidences strategies when cue information was provided during the decision phase. In sum, the above findings support the claim that when people have relatively easy access to information, they are more likely to rely on multiple pieces of information, albeit, not all participants rely on using only one strategy consistently.

Decisions Under Pressure

A ubiquitous finding among researchers interested in decision making, problem solving, and reasoning has been that people tend to use multiple strategies across tasks and even within the same task (Payne, Bettman, & Johnson, 1988; Brown, 1995; Hastie & Park; 1986).
As mentioned previously, various methods such as time pressure, cognitive load, and performance pressure have been used to increase the difficulty of accessing information and increase the costs associated with using complex strategies (Beilock & DeCaro, 2007; Bröder & Schiffer, 2003; Copeland & Radvansky, 2004; Payne, Bettman, & Johnson, 1988). Bröder and Schiffer (2006) used three dual-task manipulations (i.e., articulatory suppression, visual load, and random interval repetition as secondary tasks) to determine whether strategy selection depends upon the efficiency of the three components of the Baddeley and Hitch (1974) model of working memory. Although their findings were equivocal with regard to the Baddeley and Hitch model, the authors did observe a general trend where use of TTB increased under single task conditions. Further, use of WADD and EQW strategies decreased with the presence of a secondary task, suggesting working memory resources are an important factor in strategy selection.

To further examine the role of working memory resources during a stressful situation, Beilock and Carr (2005) investigated the role of working memory and performance pressure during a mathematical reasoning task. The authors theorized that individuals with greater working memory ability generally tend to rely on more complex reasoning strategies. If this is the case, then reducing people’s ability to utilize working memory resources such as introducing a performance pressure should result in reliance on simpler strategies. In order to test their assumptions, individuals were dived into high and low working memory groups based on their score on a working memory task (i.e., operation span) and used a combination of monetary incentives, peer pressure, and social evaluation to induce a performance pressure. . Beilock and Carr (2005) suggested performance pressures reduce available working memory resources because anxiety generates intrusive worries and thus reduces performance on tasks that require working memory resources by creating mental distractions. Only the high working memory group experienced performance decrements under performance pressure. Their interpretation was that individuals with higher working memory generally have more available attentional resources allowing them to utilize complex strategies; however, the presence of performance pressures occupy attentional resources that could have been devoted to solving the task.

In another study, Beilock and DeCaro (2007) directly examined strategy use for math problems under pressure. In one experiment, the problem solving task could be solved by using either a simpler strategy or a computationally demanding one. The task was designed such that the solutions would reflect the strategies people used to solve the problem. The results indicated the use of simpler strategies under pressure conditions. In sum, the research on performance pressure implies strategies that more heavily involve working memory resources are often abandoned under social and performance pressures. Although much of the research on performance pressure has focused on reasoning and math problems, less is known regarding the influence of performance pressure for decisions made under uncertainty. Given that more people engage in one-reason decision making under other forms of pressure, it is important to examine the possibility that performance pressure is also detrimental to decision making or results in differential strategy selection.

Rationale

Strategy selection for decisions made under uncertainty has been shown to be influenced by a plethora of factors including amount of time given to complete the task, presentation mode, individual differences in working memory, and when a distracting secondary task is present (Payne, Bettman, & Johnson, 1988; Brown, 1995; Hastie & Park; 1986). Strategy selection can be variable within individuals and tasks (Marewski & Schooler, 2011), one way to overcome this issue is to train individuals to adopt specific strategies. Once people are able to learn to use a given strategy consistently, we can then determine how strategy selection can change in the presence of social and performance pressures. In this study participants were trained to adopt either a one-reason or weight-of-evidence strategy, so that we could determine if social and performance pressures would lead to a shift in strategy selection in a manner similar to cognitive load and time pressure. A further advantage of training participants is that it will allow us to assess the impact of training on decision making performance. Some authors have observed that training attenuates the impact of pressure on performance (Hammond, 2000).

Several authors have argued that strategies considered to be more complex are often times abandoned for simpler strategies when sufficient resources are unavailable (Beilock & Carr, 2005; Copeland & Radvansky, 2004). Simple decision strategies such as TTB require less effort and cognitive resources than weight-of-evidence strategies such as EQW or WADD. Although previous work has shown that people will rely on one-reason decision strategies more often when cognitive resources are reduced, it is unknown whether using performance or social pressure will lead to a similar shift in strategy usage. Because many decisions are in fact made in pressure-filled environments, it is important to understand how decision processes can change in these situations. Depending on the range of predictive information available, the strategy selected can greatly impact accuracy. In situations where one particular cue is a much better predictor of outcomes, the use of one-reason decision strategies can lead to greater performance. However, when multiple cues are similar with respect to their predictive validities, weight-of-evidence strategies can lead to better performance. Given that some researchers have indicated that social and performance pressure can influence people to switch strategies, it seems likely that simpler strategies such as TTB would more likely to be adopted in high-stakes situations.

Hypotheses

Previous research on strategy selection and decisions under pressure suggests that simpler strategies will be adopted when participants are placed in pressure-filled environments. However, it is also possible that "raising the stakes" could increase effort and thus result in the promotion of cognitively demanding strategies.

Hypothesis 1: There should be an interaction observed for strategy selection under pressure and no pressure conditions. I expect that participants trained to use a one-reason strategy will mostly adopt this strategy under pressure and no pressure conditions. Participants trained to use weight-of-evidence strategies should use that strategy under no pressure conditions, however, under pressure conditions, participants will shift from weight-of-evidence strategies to one-reason strategies. I also expect that most participants completing the task without strategy training (i.e., control condition) will initially adopt a weight-of-evidence strategy while under no pressure conditions, but will shift towards simpler strategies under pressure.

Hypothesis 2: Reaction times should be faster for participants trained to use one-reason strategies under pressure and no pressure conditions. Without pressure, I expect participants trained to use weight-of-evidence strategies to have slower reaction times. However, I expect reaction times to decrease under pressure due to change in strategy. Similarly, I expect untrained participants to have faster reaction times under pressure conditions, because of a shift in strategy selection.

Method

Participants & Design

Sixty undergraduates[1] from Auburn University were recruited via the Department of Psychology's Research Participant Pool comprised of students enrolled a psychology courses at Auburn University. Basic demographic information was collected (age, gender, grade level) from all participants. Participants were compensated with research credit hours to be used towards a psychology course and were also given $4 for their participation. The experiment was a 3 x 2 design with strategy training (weight-of-evidence, one-reason and no strategy training) as a between-subjects factor and task condition (pressure and minimal pressure) as a within-subjects factor. The order of pressure conditions was counterbalanced across participants.

Materials

Movie Judgment Task. All participants completed the movie judgment task. The movie judgment task has been successfully implemented previously by Franco-Watkins and Johnson (2011) to classify strategy use. The movie judgment task consisted of 25 pairings of movie posters. During the task participants saw a fixation cross for 2 seconds followed by a slide displaying the names of two movies posters side by side. Participants were informed that four cues: star power, budget, movie rating, and whether or not the movie was based on an original screen play could be used to predict movie earnings. They were given explicit instruction regarding the predictive accuracy of each cue. For example, they were informed that that 80% of

[1] Due to experimental error, five participants were dropped from the analyses. One additional participant was dropped from the analyses because they refused to accept monetary compensation.

the time movies with budgets exceeding $100 million earn more money than movies with budgets of less $100 million dollars 80% of the time. Participants were informed the predictive accuracy of each cue varied so that budget, number of star actors, rating, and screenplay correctly predicted the higher performing movie 80%, 70%, 60%, 55% of the time respectively. Cue information was provided on each movie poster (See Figure 2 for example). During each trial participants were instructed to indicate the movie they believed earned more money in the U.S. at the box office by pressing "1" if they believed the movie presented on the left side of the screen earned more money and by pressing "2" if they believed the movie on the right made earned more money. The task was designed so that each movie comparison would contain one movie that would be chosen if the participant was using a one-reason strategy and the other movie would be chosen if using a weight-of-evidence strategy. Movie pairs were presented in random order. Each participant completed the movie judgment task twice under a pressure and minimal pressure condition with the order of conditions counterbalanced. Each version of the movie judgment task contained a different set of movies, so that all participants completed 50 unique trials.

Figure 2. Movie title layout for the movie judgment task.

One-Reason Strategy Training. Participants in the one-reason strategy group were informed that often times, using one reason or one cue is a better way to make judgments than considering all information. Each participant trained to use one-reason (i.e., budget because for this task it is the most predictive cue) was given five training trials with feedback. The predictive accuracy of each cue was displayed throughout training and the actual task. Each training trial began with a fixation cross display followed by the presentation of two movie posters displayed on a computer screen side by side. Participants were asked to determine whether the movie on the left or on the right had a budget exceeding $100 million. Participants responded by pressing '1' for the movie title on the left, '2' for the movie title on the right, or '3' for both. Finally, participants were asked to select the movie they believed earned more money at the box office in the U.S. After each question, participants received feedback. In order to promote the use of a one-reason strategy, the movie with the higher budget was always the move with higher earnings. In order to complete training and continue to the movie judgment task, participants needed to reach 90% accuracy for all questions during training. Zero participants failed to reach criterion on their first attempt. In order to avoid participants using information acquired during training trials, movies used during training were not used during the decision task. Upon completion of training, participants began the actual movie task.

Weight-of-Evidence Strategy Training. Participants in the weight-of-evidence strategy group were given the same general instructions as the one-reason strategy group. However, instead of being instructed that using one piece of information leads to accurate judgments, they were encouraged to use all relevant information when making their selections. Participants in the weight-of-evidence group were also given five training trials with feedback. During each training trial a fixation cross followed by two movie posters will be presented to participants. Participants in the weight-of-evidence group were asked to determine whether they believed the movie on the left or on the right had a budget over $100 million. However, they were also asked to determine if one movie or both movies had at least three roles played by “top hollywood stars”, if the movie was rated PG-13, and if the movie was based on an original screenplay. Finally, participants in this group were asked to select the movie they believe grossed more money at the box office in the U.S. Participants were required to reach 90% accuracy during training in order to continue to the movie judgment task. Zero participants failed to reach criterion on their first attempt.

No Strategy Training. Participants assigned to the no strategy training group were given the same instructions as both training groups. However, they were not informed of the effectiveness of a particular strategy. Participants in this group were simply informed that four cues are predictive of box office earnings and they should be used to help them select their choices. Participants in the no strategy group were also given 5 practice trials with feedback.

Social and Performance Pressure. The social and performance pressure manipulation was adapted from Beilock and DeCarro (2007). The pressure manipulation uses a combination of monetary incentives, peer pressure, and social evaluation. This manipulation has been shown to be highly effective at inducing feelings of performance pressure and anxiety in participants (Beilock & Carr, 2001; Beilock & Carr, 2005; Beilock & DeCarro, 2007). Participants were informed that if they correctly answered 83% of the questions correctly they would receive $2 for their efforts. Further, participants were informed that in order to receive the reward they must not only achieve 83% accuracy but they were also randomly assigned a partner that must also score 83% correct in order to receive their reward. Before completion of the movie task, participants were informed that their assigned partner had already achieved a score above 83%.

Finally, participants were told that they would be videotaped during the task and that University faculty would examine their performance.

Felt Stress Questionnaire. In order to assess the efficacy of the social and performance pressure manipulation, a felt stress questionnaire designed to ask specific questions regarding the stressfulness of the movie judgment task was used. The felt stress questionnaire asked participants to rate statements such as, “I felt pressure to perform well on the task”, on a 5-point scale ranging from 1 (strongly disagree) to 5 strongly agree. This questionnaire was used to measure perceived felt stress during the movie judgment task. See Appendix A for the complete questionnaire.

Procedure

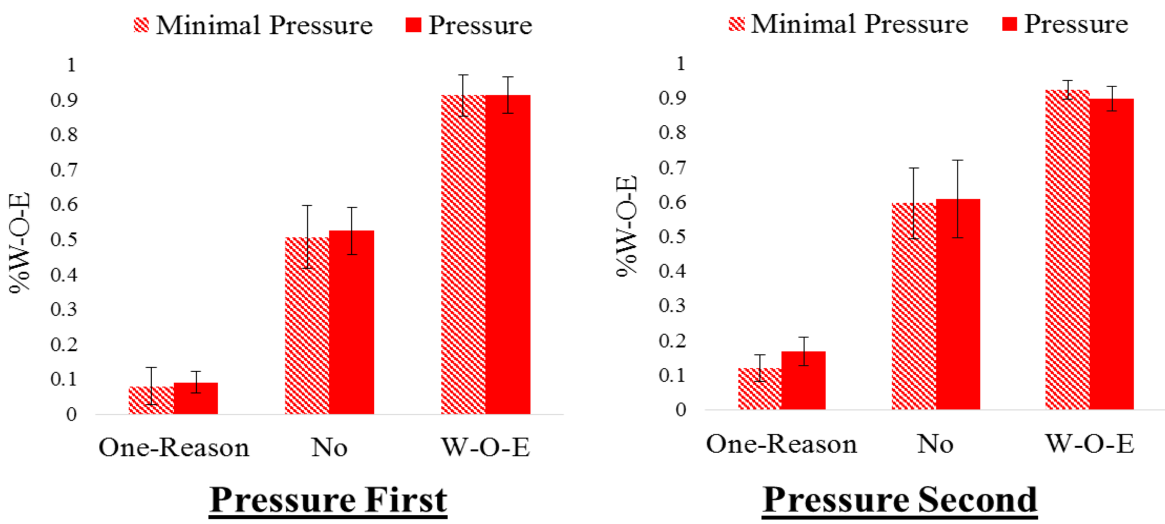
Participants accessed and signed up for available lab sessions through the Department of Psychology’s Participant pool managed via Sona Systems. Upon arrival to the lab, participants consented to taking part in the study, and were randomly assigned to either a no training group, a one-reason decision strategy group or a weight-of-evidence strategy group. Participants were given brief verbal instructions prior to beginning the study and were given detailed instructions provided on a computer screen throughout the experiment. Participants in one-reason and weight-of-evidence groups completed the decision strategy training prior to beginning the movie judgment task. Once participants completed the movie judgment task they were given the felt stress questionnaire, followed by implementation of the social and performance pressure manipulation. Once the pressure manipulation was implemented, all participants completed a second block of the movie judgment task consisting of 25 new trials. Blocks of judgment trials were counterbalanced across pressure and no pressure conditions. Once each participant completed the movie judgment task for the second time, they were given the felt stress questionnaire again. Once each participant completed the movie knowledge task they completed a short demographics questionnaire, and were fully debriefed.

Results

Training

Before addressing my hypotheses it is important to ensure the pressure and training manipulations were successful. The training manipulation was very successful as participants trained to use a one-reason or weight-of-evidence strategy were able to implement their trained strategy successfully across pressure and no pressure conditions. The mean percentage of choices consistent with a weight-of-evidence strategy were *M*=.91, *SD =.13* for the weight-of-evidence group, *M*=.12, *SD* =.10 for the one-reason group, and *M* = .56, *SD* = .27 for the no training group. I conducted a 3 X 2 X 2 ANOVA with training and order as between-subjects factors and pressure as a within-subjects factor. As can be seen in Figure 3, the effect of order on choice was not significant $F(1, 50) = .85$, $p = .36$, $\eta^2_p = .02$. Because there was no effect of order a 3 X 2 ANOVA with training as a between-subjects factor and task condition as a within-subjects factor revealed a main effect of training $F(2, 53) = 84.52$, $p < .01$, $\eta^2_p = .77$ on the percentage of choices consistent with a weight-of-evidence strategy. The weight-of-evidence group made more choices consistent with a weight of evidence strategy than both the no training group t(35) = 5.04, $p <$ .01, and the one-reason group t(35) = 19.71, $p < .01$. The no training group made more choices consistent with a weight-of-evidence strategy than the one-reason group t(34) = 6.22, $p < .01$.

Figure 3. Mean percentage of weight-of-evidence choices under minimal pressure and pressure conditions by order of condition and training group.



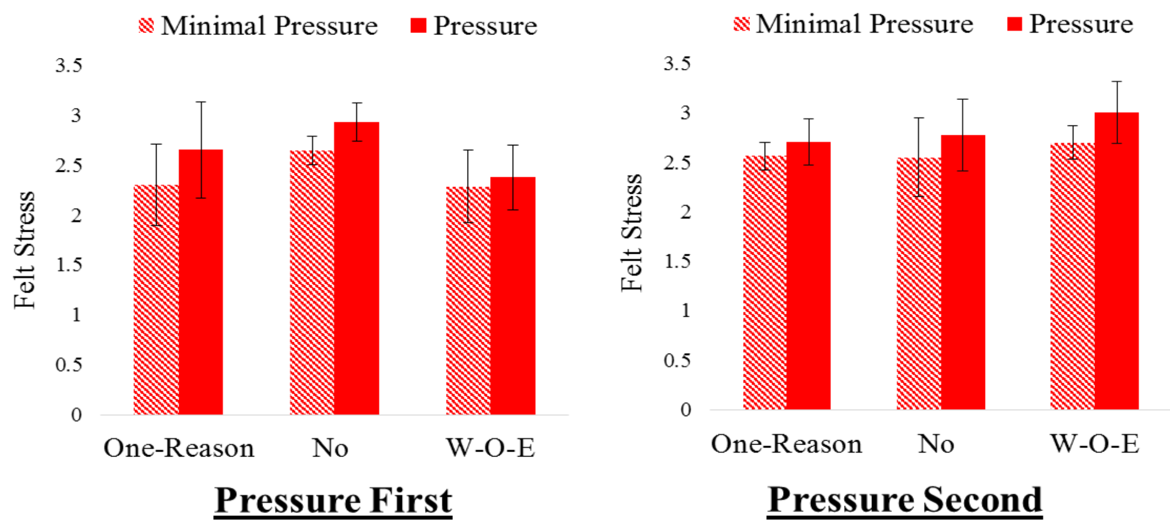
Felt Stress

Participants indicated their perceived felt stress after each iteration of the movie judgment task on an 8-item questionnaire. Four of the questions were reversed scored. All eight items were averaged for each participant, with higher scores indicating greater perceived felt stress (M = 2.50, SD =.66, range = 1.00 - 3.625). In order to assess the reliability of the items within the questionnaire a Cronbach's alpha was used which indicated the measure was indeed reliable (α = .80). A 3 X 2 X 2 mixed ANOVA with training (one-reason, weight-of-evidence, and no training) and order (pressure first and pressure second) as between-subjects factors and pressure (minimal pressure and pressure) as a within-subjects factor in order to assess the impact of the pressure manipulation on self-reported felt stress[2]. As can be seen in Figure 4, the effect of order on felt stress was not significant $F(1, 29) = .62$, $p = .44$, $\eta^2_p = .02$. Therefore, the remaining analysis of felt stress does not include order as a factor. The analysis revealed a main effect of

[2] Nineteen participants were not included in the data analyses of the felt stress questionnaire because their responses were not collected due to a glitch in the data collection software.

pressure, $F(1, 32) = 7.82$, $p = .01$, $\eta^2_p = .20$. The effect of training on felt stress was not significant $F(2, 32) = .28$, $p = .76$, $\eta^2_p = .02$ and there was no interaction between pressure and training $F(2, 32) = .10$, $p = .91$, $\eta^2_p = .01$.

Figure 4. Mean felt stress ratings for minimal and pressure conditions by order of condition and training group.



Strategy, Training, & Pressure

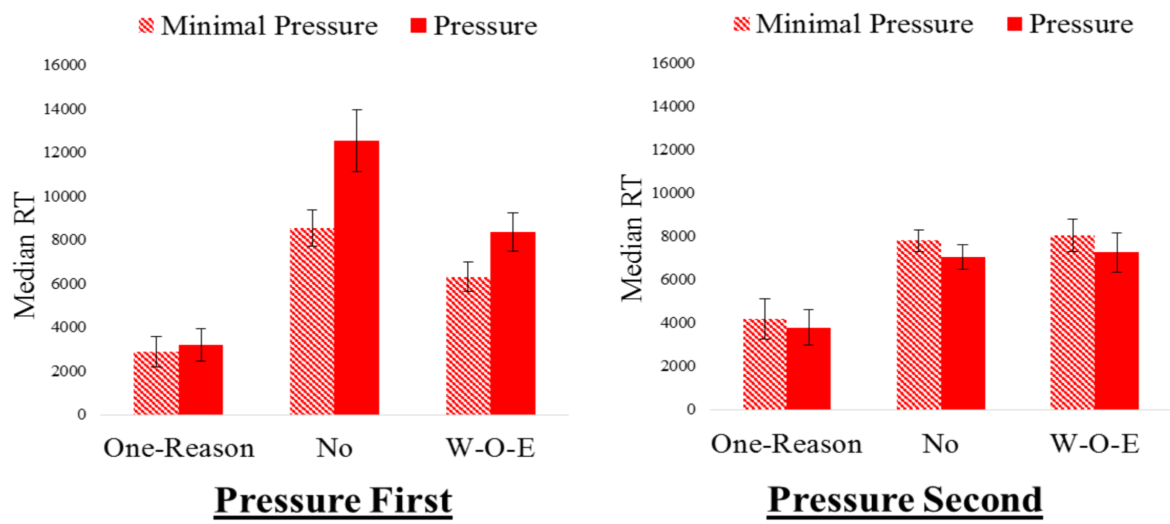
For hypothesis 1, I proposed an interaction between task condition and training where participants trained to use a particular strategy would maintain their strategy under pressure and participants who were not given explicit training would switch to a one-reason strategy under pressure. As noted in the training subsection the effect of order failed to reach statistical significance, therefore, in order to assess level of support for hypothesis 1, I used a 3 X 2 mixed ANOVA with training as a between-subjects factor and pressure as a within-subjects factor. As can be seen in Figure 3, the type of training had a clear effect on the percentage of choices consistent with a weigh-of-evidence strategy $F(2, 51) = 81.76$, $p < .01$, $\eta^2_p = .76$. However, contrary to my hypotheses there was no effect of pressure on strategy selection $F(1, 51) = .04$, $p = .84$, $\eta^2_p = .01$ and no interaction between pressure and training $F(2, 51) = .54$, $p = .58$, $\eta^2_p =$

.02. Participants, regardless of training, appeared to show remarkable consistency in their strategy use across pressure conditions. The vast majority of participants displayed a strong preference for a certain strategy (or at least a preference for a specific strategy mixture) and used their preferred strategy in spite of pressure. I used a Pearson's correlation to demonstrate the relationship between weight-of-evidence choices under pressure and no pressure conditions, r(52) = .96, $p < .01$.

Training, Pressure, & Reaction Time

For hypothesis 2, I proposed reaction times should be faster for participants trained to use one-reason strategies under pressure and no pressure conditions. Without pressure, I predicted participants trained to use weight-of-evidence strategies would have slower reaction times. However, I expected reaction times to decrease under pressure due to a shift in strategy selection. I also expected that people without strategy training to have quicker reaction times with a shift in strategy selection. As with choice, the effect of order was not significant $F(1, 48) = .84$, $p = .37$, $\eta^2_p = .02$, however, there was a significant 3-way interaction between training, pressure, and order $F(2, 48) = 7.07$, $p < .01$, $\eta^2_p = .23$. Therefore, order was included in subsequent analyses. As expected training had a statistically significant effect on RT $F(2, 48) = 23.39$, $p < .01$, $\eta^2_p = .49$. Participants trained to use a one-reason ($M = 3542.62$, $SD = 2343.36$) strategy were significantly faster when making choices than the weight-of-evidence group ($M = 7588.11$, $SD = 2165.94$), t(34) = 5.38, $p < .01$, $d = 1.85$ and no training group ($M = 8668.53$, $SD = 2154.14$), t(33) = 6.74, $p < .01$, $d = 2.35$. Under pressure participants performed more slowly than under the minimal pressure condition $F(1, 48) = 11.72$, $p > .01$, $\eta^2_p = .20$. However, as can be seen in Figure 5, the effect appears to only be present for participants who completed the movie task under the pressure condition first. Post hoc analysis reveals that the difference between pressure conditions in the no training group was different when the pressure condition came first t(8) = 3.96, $p < .01$, $d = 1.31$. Similarly, the weight of evidence group performed more slowly under pressure when the pressure condition was first t(9) = 5.68, $p < .01$, $d = 1.74$.

Figure 5. Median RTs for minimal pressure and pressure conditions by training and order of condition.



Discussion

Unlike other types of pressures (time, dual-tasking) there appeared to be minimal shifts in strategy selection on our task. Trained and untrained participants alike demonstrated a clear tendency to adopt a strategy and maintain that strategy regardless of social and performance pressures. As evidenced by the strong relationship observed between choices on the movie task under pressure conditions, people seemed to adopt a particular strategy or find a mixed strategy and maintain that strategy in the face of performance pressures.

Although pressure seemed to have little impact on strategy, the possibility remains that pressure may still impact strategy selection. The strategy classification method employed in this study was insensitive to relatively small changes in strategy selection. The primary interest of the current study was to distinguish between weight-of-evidence strategies and one-reason strategies.

Within the category of weight-of-evidence strategies there are a variety of strategies one could employ. Given the design of the movie task it was impossible to distinguish between participants using a WADD strategy from participants using an EQW strategy. Whereas WADD involves weighting each cue according to its ability to make accurate predictions, EQW simply requires counting the number of cues present for each option. Both of these strategies utilize all relevant information, however, the WADD strategy demands greater cognitive resources (Payne, Bettman, & Johnson, 1988). Similarly, under pressure it is possible that participants were using a modified version of the WADD strategy. Glöckner and Betsch (2008) have shown that participants in some situations, especially when resources are limited, use a modified version of WADD; WADD automatic. According to Glöckner and Betsch (2008) participants can use WADD automatic to reduce the number of steps required to employ a WADD strategy. The underlying rationale behind my hypotheses was that pressure should reduce the amount of cognitive resources available to employ a complex strategy. Given the design of this experiment, participants could have potentially used a weight-of-evidence strategy that was less demanding under pressure rather than switching to one-reason strategies.

Another possibility is pressure may have a limited impact on strategy selection for tasks that are more familiar to participants. Beilock and Carr (2005) and Beilock and DeCarro (2007) observed shifts in strategy selection on several mental arithmetic tasks. In one version of the task participants were told that they would be given three numbers in a fairly unusual format (i.e., 51=19 mod 4). The participants were asked to subtract the first number from the second (51-19=32) then divide the new number from the third number (32/4=8). They were then asked to determine whether the final number was a whole number or if it had a remainder. Participants could answer with true or false. They answered “true” when the final number was whole, and “false” when the final number had a remainder. For many participants this may have been the first time they had to solve problems in this particular format and may have thus been less able to maintain a complex strategy with limited familiarity with the task. The task used in this study, however, should have been more familiar to participants possibly enabling them to continue to use more complex strategies. Yet another possibility is that performance pressures may have a greater impact on strategies for decision tasks that require memory retrieval. Bröder and Schiffer (2006) observed greater reliance on one-reason strategies when participants were engaged in a working memory taxing secondary task. One key difference between this study and our own (aside from the type of stressor) was that participants in their study had to retrieve cue information from memory rather than rely on information presented on screen. Earlier studies investigating strategy selection had also confirmed that one-reason strategies tend to be used more often when participants are restricted to using only the information they can retrieve from memory (Bröder 2000, Newell & Shanks, 2003). Some studies have also shown that requiring participants to retrieve information from memory not only increases one-reason decision making, it also increases the use of one-reason strategies. In one experiment Bröder and Gaismaier (2007) found that not only did one-reason decision making increase when memory retrieval was necessary, participants also relied on the first cue they could retrieve that discriminated between options rather than attempting to retrieve the most predictive cue that discriminated between options.

In a review of the strategy selection literature, Bröder and Shanks (2008) challenged the view that people adopt simple strategies because of a limited ability to process and manipulate information. They argued that most people easily employ complex strategies when information is provided to them on a computer screen. The basis for their argument is that secondary tasks only seem to cause a change in strategy selection when information must be retrieved from memory. Furthermore, contrary to the view that information processing ability dictates individual strategy choices, intelligence is in fact correlated with using one-reason decision strategies such as take-the-best. Bröder and Shanks (2008) argue that the most challenging aspect of strategy selection is not the manipulation of the information, but is instead the process of determining the best strategy in a new decision environment. Our findings seem to support this view, as there was no evidence to suggest that people were any less able to use a weight-of-evidence strategy under pressure. However, pressure does increase reaction time, especially for participants who were not given explicit training. Beyond the actual training in one strategy over another, the group that was not trained in the current study was never told which strategy was more effective. The increase in reaction tine for the no training group could be interpreted as increasing the difficulty associated with choosing one strategy over another.

Future work should address some of the limitations in the current study. Social and performance pressures may prove to impact strategy use when participants are under greater demands. One way to make the task more demanding would be to require participants to learn the cue values associated with each movie option prior to making judgments. This way participants would be forced to retrieve the information necessary to employ a weight-of-evidence or one-reason strategy. The task itself could be made more demanding by forcing participants to make judgments between several alternatives rather than just two or by making the cue validities variable. Finally, future work could use a more refined measure of strategy use in order to assess the impact of social and performances pressures. By modifying the predictive validities of the movie task, one could discriminate between choices consistent with a EQW strategy and a WADD strategy. This would allow for discrimination between different weight-of evidence-strategies.

In conclusion, no evidence was found indicating participants switched strategies under pressure. Although it is possible that participants switched to using simpler strategies that were undetectable given the design, it seems just as likely that people are able to maintain relatively complex decision strategies such as the WADD. Future work should address this particular limitation as it may offer some insight into the limitations of human decision making. In most environments a WADD strategy is superior in terms of accuracy to a simpler EQW strategy, thus ruling out this interpretation may be helpful for those interested in training people to use optimal decision strategies under stress. In this study we did find that when not given explicit guidance regarding which strategy should be used, reaction time did increase for our task. These findings could be useful for decision training in the real world. Because we know that in a variety of environments some decision strategies are better than others, it may be useful to offer some strategy training to people who are in positions where they must make quick and accurate decisions.

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Appendix A

Felt Stress Questionnaire and Instructions

Perceived Pressure: You will now be asked to indicate the extent to which each of the following statements produced pressure with regard to the tasks you just completed. Responses will be made by pressing the '1', '2', '3', '4', or '5' keys on the number pad on the right side of the keyboard.

1. Strongly disagree
2. Somewhat disagree
3. Neither agree nor disagree
4. Somewhat agree
5. Strongly agree

<u>Statements</u>

I felt pressure to perform well on the task
I felt that I could control how well I performed on the task I felt stressed during the experiment
In general, I was in control of what happened in the task I felt challenged by the task

I was able to perform well on the task
I thought about how poorly I was doing on the task
I am satisfied with my overall performance on the task