The influence of affect on suboptimal strategy choice in the Monty Hall dilemma

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The Monty Hall dilemma (MHD) presents an intriguing choice anomaly that offers insight into human reasoning. It presents a specific subclass of decision tasks that require the adequate use of Bayes theorem in order to make optimal decisions. In the MHD, participants are presented with three doors with only one door hiding the prize. After their initial choice of a door, they are offered additional information. A different door (one that does not hide the prize and one not chosen by the participant) is opened to reveal nothing behind it. Afterwards, the participants are offered to stay with their initial choice or to switch to the other remaining door. The better strategy is to always switch; a counterintuitive one for most people. We examine the notorious difficulty of the MHD from an affective perspective while relying on the dual processing approach to thinking. We varied participants’ reliance on their affective reactions as opposed to a neutral condition and hypothesized that the affective reactions associated with the staying option contribute to worse performance on the task. Indeed, the participants in the affective condition chose the staying option more often than our control participants. Using the MHD as an appropriate paradigm of conditional probability reasoning we show that, for this type of task, an affective strategy is highly inefficient. We attribute these results to the affective reactions associated with the staying option, with regret avoidance associated with the switch option, and the conditional probability construction of the dilemma.

Keywords: Monty Hall Dilemma; Affect Heuristic; Conditional Probability; Dual Processing Theories

The Monty Hall dilemma (MHD), named after the host of the game show “Let’s make a deal”, represents an intriguing task studied for its insight into human reasoning with chance and probability. It has time and time again been found to be incredibly difficult for people (e.g. Granberg & Brown, 1995; Saenen, Van Dooren, & Onghena, 2014). The MHD involves a person choosing one of three doors. One door hides a prize (e.g. a new car), and the other hides some type of gimmicky item (for the purposes of the show this was usually a goat). After a person makes a choice, Monty opens one of the three doors (never
the one which the participant has initially chosen or the one containing the prize) revealing nothing behind it. The person is then asked whether he or she would like to stay with their original choice or to switch to the other unopened door. The correct strategy is to switch to the remaining door (Vos Savant, 1990). More precisely: switching loses, only if the player has initially chosen the door that hides the prize, but, since this only happens with a 1/3 chance, it means that switching wins with a chance of 2/3. The real difficulty of the dilemma however, hides in its conditional structure. Monty (or any incarnation of his function) has, by opening one door, decided not to open a different one, which makes his choice, non-random. The optimal solution hinges on taking this event into account. The dilemma can also be solved by relying on Bayes theorem (see Gill, 2011) and is considered a perfect example of a task where the necessity to update one’s prior beliefs is clearly beneficial. Studies have repeatedly shown that people prefer the staying option with staying rates ranging from 79% to 91% (e.g. Burns & Wieth, 2004; Krauss & Wang, 2003; Rosenthal, 2008). The pervasiveness of the problem has been shown in many studies, even with multiple trials, as well as cross culturally (e.g. Granberg, 1999a, 1999b; Granberg & Brown, 1995).

The relevance of the MHD in the mathematical domain as well as a pedagogical tool for basic statistics teaching is undeniable, but the psychological value of the dilemma is interesting for a different reason. Slembeck & Tyran (2004), for instance, stress that Bayes theorem is one of the foundations of modern economic theory and that the prevalent behavior on the MHD, shakes the core of the economics of uncertainty. It would therefore be of note to examine the influence of a particular heuristic or strategy on said behavior as it provides an analogous insight for certain real world decisions. For example, people can make a prediction or choice (whether using some strategy or randomly) and then fail to note some new information by sticking to their initial choice. Such behavior is emblematic of certain consumer and choice dilemmas which are associated with stock market trading, corporate finance, poker and other gambling scenarios. Furthermore, in medical decision making, people often misrepresent the odds of them having a certain illness after a result from a test and commit to certain treatments. Once people find out the incidence of the disease (i.e. new information), they can choose to stick to their original, prescribed treatment, or switch to a different one (see Fiedler, Brinkman, Betsch, & Wild, 2000). The many applications and examples of conditional probability judgments have warranted much research on this topic. Mostly, the focus has been on attempts to change the working conditions of the task and trying to find a suitable explanation employing various cognitive heuristics that people supposedly adhere to (Franco, Watkins, Derks, & Daugherty, 2003; Gilovich, Medvec, & Chen, 1995; Tubao & Alonso, 2003). In this paper we focused on the role of affective feelings as potential determinants of performance in the MHD. Precisely, we propose that affect which arises as an integral reaction (i.e. affect as a product of direct experience with the object of judgment), associated with the staying option, could lead to sub-optimal decisions in the MHD. Affect and affective reactions are being increasingly used to explain judgment and decision
making related phenomena and we believe it could offer a potentially different perspective on the MHD (Gross & Barrett, 2013; Loewenstein & Lerner, 2003).

**Affect and decision making within dual processing theories**

It has been shown that when people are faced with uncertainty and complexity in decision making, they are guided intuitively by feelings arising from an experiential mode of thinking (Finucane, Alhakami, Slovic, & Johnson, 2000). The reliance on these feelings has been dubbed the *affect heuristic* (AH); where experienced feelings are used as information to guide judgment and decision making (Schwartz & Clore, 1988). Therefore, given its potential influence on cognitive processes, affect was integrated in dual processing theories as one of the key determinants of decision making. In general, these theories make a distinction between two systems that individuals rely on to make their choices: intuitive and deliberative (e.g. Epstein, 1994; Evans, 2008; Kahneman, 2003; Stanovich & West 2000). The intuitive system (system 1/type 1) is considered to be experiential and is characterized as quick, automatic and affective. On the other hand, the deliberative system (system 2/type 2) is considered to be slow, controlled and analytic. For instance, Cognitive Experiential Self Theory (CEST; Epstein, 1994) presupposes that when people are faced with decisions, there are multiple sources of information to consciously consider, including “hot” and “cold” cognitions. The former stream of information is emotional in nature, whereas the latter involves “rational” and deliberative processes (see, e.g. Janis & Mann, 1977). It is also of note that reliance on affect and emotion is a quicker, easier and sometimes more efficient way to navigate in a complex and uncertain world. Furthermore, within the framework of CEST, the AH (Finucane et al., 2000), offers the possibility to clearly demarcate the influence of individual systems on judgment and decisions. For example, with the framework of the AH it was suggested that certain alternatives can be “marked” by a degree of positive or negative affect or as Slovic, Finucane, Peters, & MacGregor (2002) put it: “using an overall, readily available affective impression can be far easier – more efficient – than weighing the pros and cons or retrieving from memory many relevant examples, especially when required judgment or decision is complex or mental resources are limited” (p. 400). Just as imaginability, memorability and similarity serve as cues for probability judgments, affect, may serve as a cue for many important judgments.

**The potential role of affect in the MHD**

Based on some prior work (e.g. Gill, 2010; Gilovich et al., 1995; Granberg & Brown, 1995), we hypothesized that people choose to stay with their initial decisions because they feel more negative about switching and losing, than they feel positive about switching and winning. In other words people associate

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1 For a growing discussion on the direction and critiques of dual processing theories see Evans (2011) and Evans and Stanovich (2013).
a more positive affective response when they stay with their initial choice. This presupposition has been previously evoked but never, to the best of our knowledge directly tested with the MHD. For instance, Granberg and Dorr (1998) evoke the illusion of control to show that people, in effect, feel more attached to their initial choice. By making their participants believe that someone else has made their first choice, when in fact a computer randomly chose a door, their participants were more likely to switch to the other door (although not in 100% of cases). One might postulate that their participants did not get the chance to form an affective reaction to their initial choice because they were denied the direct experience and therefore chose to switch more often. In a highly modified version of the MHD, Gilovich et al., (1995) showed that subjects who switched from their choice were experiencing greater dissonance when confronted with the result. Thus, one could speak of an anticipation of regret i.e. that people who switched from their initial choice anticipate feeling greater regret if they were to switch away from the prize. Similarly, Kahneman and Tversky (1982), claimed that someone who sells one stock and buys another, only to lose money on the deal, is predicted to feel worse, than someone who considers switching stocks but stays with his original choice and then loses an equal amount.

We extend the reported findings and provide affect as a novel perspective that could influence performance on the MHD. We hypothesized that reliance on affect will lead to bad decisions (i.e. staying with initial choice) and to less applying of the correct strategy. Consistent with this assumption, Petrocelli and Harris (2011) recently found that the memory for switch loses was significantly overestimated and that participants tended to counterfactualize their switch loses. In a similar manner, Kirkeboen, Vasaan, and Teigen (2013) have found that changing one’s mind for a particular decision carries a cost. In a sense, people feel more regret when changing their mind, irrespectively of the outcome, thus indicating that sticking to one’s initial choice is some sort of “preservation” strategy. These examples allow us to segway into our proposition. Note that we are invoking affect in its advisory role, as proposed in the seminal paper by Loewenstein and Lerner (2003) i.e. what is most commonly referred to as anticipatory affect. Anticipatory affect relates to integral influences of emotion. This is affect that arises upon presentation of a stimulus or as a reaction to it i.e. it is integral to the decision situation. It is important to differentiate it from incidental affective influence, which is when pre-existing moods or emotions influence unrelated decisions (see also Knutson & Greer, 2008; Winkielman, Knutson, Paulus, & Trujillo, 2007, for a more detailed description). Given the MHD’s initial random feature (the prize is hidden behind one door randomly), there is a possibility that people will win a prize when staying with their initial choice. After all, there is a 1/3 chance that they pick the right door at the begging. This coupled with the previous evidence showing that people value staying with their initial choice more positively, could cause a positive cue to be associated and overestimated with staying (Gill, 2010; Gilovich et al., 1995). And since positive cues tend to be reproduced (Epstein, 1994), people will choose the staying option, despite their worse performance. The positive affective cue, in the case of staying and wining overpowers all other
valuing attempts. This, in turn, would lead people to rely on the staying option considerably higher, even across multiple trials.

The present study

In this study participants were exposed to 60 trials of a computerized version of the MHD. We chose this number of trials because previous research has shown that even after 200 trials, people do not make optimal choices and that no improvements in strategy or outcome was visible in the last 150 trials (Herbranson & Schroeder, 2010). We can thus, at least ostensibly, exclude the learning through experience option. To test the role of affect in decision strategy, we explicitly manipulated the extent to which participants rely on their feelings during the task. Half of the participants performing the MHD were instructed to pay attention and rely on their feelings, while the other half did the same task, with basic instructions (see Appendix). If affective feelings play a role in the MHD then participants in the reliance on feelings condition should choose the staying option considerably more frequently than participants in the control condition. By extension, it means that the experimental group would have a worse performance, measured by number of points won.

Method

Participants

Thirty six psychology students (30 female; \(M_{age} = 19.8, SD = 0.82\)) from the University of Sarajevo participated in exchange for course credit. The participants were randomly assigned to one of two groups: control and reliance on feelings.

Monty Hall Dilemma

We used an iterated version of the dilemma with 60 trials. A standard interface was used with three doors presented at first. After the initial choice, participants could click on buttons labeled either “stay” or “switch” to make their final choice. They were notified after each decision whether they were successful or not. The next trial came automatically after. In order to ensure a visually presentable MHD task, a completely new version was programmed using Visual Studio 2010 to give it a cleaner interface and smoother controllability. The code used for the task was simulated 60 times with 60 repetitions for every strategy in order to ensure that there was nothing wrong with the programmed structure, i.e. to check if one really did win \(\approx 0.67\) times when switching and/or \(\approx 0.33\) times when staying. Indeed, when the program was instructed to switch on all trials the average result of wins was 39.7, which represents 66.2%. Similarly for staying where the average result of wins was 18.2, which represents 30.3%. The participants used a computer mouse to manipulate the task.

Materials and Procedure

The participants performed the task individually. Special care was taken pertaining the instructions as considerable controversy exists regarding the mathematical language used when presenting the MHD (Sadri, 2012). The standard instructions do not include the
information about Monty Hall’s intentions i.e. why he opened a specific door (maybe he did not know behind which door the prize is hiding or perhaps, his intentions were malevolent). However, as Krauss and Wang (2003) pointed out, in psychological terms, this is not relevant per se as the participants are being asked to make a decision. Participants normally assume that the door which was opened cannot be the one that hides the prize, or the one which they have already chosen. We therefore presented a version of the instructions used in previous work (e.g. Harbranson & Schroeder, 2010; Tubau & Alonso, 2003; see Appendix). In the reliance on affect condition participants were instructed to take into account how positive or negative they feel regarding each choice and to make their final decision using their affective insights and emotions (e.g. Cheung & Mikels, 2011; Mikels, Maglio, Reed, & Kaplowitz, 2011). Additionally, after every tenth trial, participants were asked to provide an answer to the question “to what extent did you rely on your affective reactions while making the preceding choices”, on a scale from 1 (not at all) to 7 (completely). These questions were presented primarily in order to reinforce the participant’s reliance on their emotions and as a potential measure of reliance on affect. The participants in the control condition received only the basic instructions about the rules of the dilemma. Posing the same question would result in unintentionally guiding the participants to perhaps rely on their affective reactions and we wanted to avoid any confounds in the control group that could sway their strategy choice. Thus, we decided not to present these questions in this group.

Previous research showed that people might differ in the extent to which they pay attention to their feelings (Salovey, Mayer, Goldman, Turvey, & Palfai, 1995; Swinkels & Giuliano, 1995). Thus, to determine if both experimental groups were equivalent in this preexisting disposition, at the end of the experiment, the participants completed the Attention to emotion subscale of the Trait Meta-Mood Scale (Salovey et al., 1995) that measures the degree to which individuals notice and think about their feelings (e.g. “I pay a lot of attention to how I feel”; do you agree, 1 = not at all; 5 = completely). Because participants were presented with an assignment with a large number of trials, we wanted to ensure that they would not satisfice on the responses for the attention scale i.e. since the experiment requires participants to be highly attentive and involved in their decision task we wanted to ensure that they would not skim the questions presented at the end because of fatigue. With that in mind, we included an instruction manipulation check (Oppenheimer, Meyvis, & Davidenko, 2009). At the very beginning of the questionnaire a question was inserted in which the participants were asked to respond with a “5”. If the participant answered with anything other than that, the program would stop and they would receive additional instructions to be more attentive to the task at hand. Finally, both groups went through a standard debriefing procedure. None of the participants stated that they previously knew about the MHD or the correct solution.

Results

The preliminary analyses revealed that participants in the two groups did not differ regarding the time they needed to make their decisions ($M_{control} = 1599.7$, $SD_{control} = 678$; $M_{ROF} = 1672.2$, $SD_{ROF} = 626.6$, in ms), as well as regarding the general disposition to rely on feelings ($M_{control} = 3.97$, $SD_{control} = 0.67$; $M_{ROF} = 4.02$, $SD_{ROF} = 0.66$), all $ps > 0.05$. These findings suggests that potential confounds related to these differences cannot account for the expecting effect of our main manipulation.

Consistent with our expectations, the participants in the reliance on feelings condition used the staying strategy more often ($M_{ROF} = 39.5$, $SD_{ROF} = 8.7$), than participants in the control condition ($M_{control} = 29.1$, $SD_{control} = 8.8$), $t(34) = -$
3.47, \( p = 0.001 \), \( d = 1.17 \). Consequently, the reliance on feelings group was less successful than the control group, \( t(34) = 2.72, p = 0.01, d = 0.92 \) (\( M_{\text{ROF}} = 26.8, SD_{\text{ROF}} = 4.2; M_{\text{control}} = 31.5, SD_{\text{control}} = 6.0 \)). We also found a positive correlation between measure of reliance to affect during the task and the staying strategy. Participants who reported that they relied more on their affect while making their decisions, also used the staying strategy more often, \( r = .528, p = 0.025 \).

**Discussion**

We are every day faced with multiple decisions related to consumer behavior, investments and health. Similarly, when making these decisions we often rely on our feelings and intuitive reactions to guide us. The MHD is a striking example of a choice paradigm with a wider application, where our intuitions fail us miserably. The present experiment aimed to provide the first indications that it is our affective reactions that could have a detrimental impact on conditional probability judgments. Consistent with our expectations, the participants who were explicitly asked to take into account their feelings used the staying strategy more often than the participants in the control group. Importantly, the results showed that these two groups did not differ regarding the time needed to make their decisions. This finding suggests that the participants in the affective condition which prominently utilized the staying strategy were in similar processing conditions i.e. the instructions they received were not distracting which means that their performance on the MHD was due to strategy choice – staying. Furthermore, in line with this assumption we found a positive correlation between the answers on the reliance on affect measure (the extent of reliance on affect in the preceding trials) and the staying rate. Even though previous studies that dealt with the MHD did not test for affect directly, focusing more on cognitive explanations, our results are in line with their general conclusions that people do have a disproportionate tendency to use the staying strategy (Granberg & Brown, 1995; Granberg & Dorr, 1999; Herbranson & Schroeder, 2010; Saenen et al., 2014). However, by showing that when people rely on affect they choose the staying option more, we illustrate the potential role of this effect. Similarly, by operationalizing our approach with dual processing theories, specifically CEST, we further extend the reliance on this theoretical proposal. A dual processing model has also provided us with the ability to influence the way participants encoded information and constructed their attitudes towards the staying option in our experiment. According to the theory, individuals rely on both their affective and deliberative approach at the same time (Evans, 2008). By ostensibly isolating one of the systems, we were able to identify the effects of one of these types of processing without the interference of the other.

One could argue that the results we obtained are not necessarily due to affect. For instance, De Neys (2007) found that people generally rely on an equiprobability heuristic, i.e. they believe that in the second part of the game, when one door has been removed, the chances of winning by staying are 50 %.
Considering that the real chances of success are distributed such that the choice to switch was the better strategy with 67% winning chance, we can easily measure the potentially detrimental effect of such belief. In our study, participants in the control group indeed choose to stay around 50% of the time (48.5% precisely). However, those in the reliance on affect group applied a completely different strategy with a staying rate of 65.8%, which clearly suggest that equiprobability heuristic cannot account for our findings in this condition.

Another alternative explanation that has been evoked, primarily when trying to explain the deleterious results in the MHD, is probability matching (McDowell & Caron, 2010). For instance, if individuals are presented with a version of the MHD with 50 trials, on average, their overall results could match the probability of gaining the prize for each choice, so they would switch ≈30 times and stay ≈20 times. Although not necessarily a heuristic, it is presumed that probability matching reflects, not a lack of an optimal cognitive strategy, but a presence of a suboptimal one (Gaissmaier & Schooler, 2008). Again, the present results are in a mismatch with this explanation since the participants show a markedly different distribution of choice strategy. Specifically, the participants induced to rely on affect were not following the probability matching strategy as they stayed significantly more often than in 33% of trials (CI 99% 23.43 to 42.07) from the theoretical average of 33,

\[ t_{(19)} = 10.05 \quad p < 0.001 \]

Research suggests that affect is not always detrimental for decision-making. Therefore, one question that still remains is how to reconcile our results with prior findings? For instance, affect has been shown to lead to better decisions across multiple trial tasks e.g. the Iowa Gambling Task (IGT, Bechara, Damasio, Tranel, & Damasio, 1997). Contrary to this, reliance on affect in the MHD has led to suboptimal decisions across the entirety of the task. It is important to understand why this might happen for decisions of the conditional probability type. Shiv, Loewenstein, Bechara, Damasio, and Damasio (2005) have shown that reliance on affect leads to suboptimal decisions when they constructed a task which was not suitable for affective guidance. Thus, task type is important when one speaks of the possible detrimental or advantageous role of affect in decision making. For instance, within the context of the IGT, the “good” decks are always the same. The payoffs could be different but, overall, choosing only those decks is advantageous in the long run. In other words there is a negative correlation between the riskiness of the decks and their long-term expected monetary value, so an affective strategy of choosing only the decks that have previously served us well is beneficial. The MHD on the other hand, within its first step has an inherently random choice. You do not know where the prize could be and therefore in the beginning, you make a random decision. Therefore, an affective reaction is associated with the first part of the decision (with one’s initial choice), effectively making the second part (the conditional and the more important one) obsolete. So people fail to update their initial affective reactions and lose out. This is relevant outside the laboratory as well since we can also safely assume that most of the choice dilemmas in real life do not have a fixed distribution of probabilities (such as the IGT). Because of that, the necessity
to understand the potential role of affect in types of task that approximate a real world decision in that they have an inherently random structure (as the MHD) is vital. Furthermore, since this is a highly complex task, people might disproportionately (i.e. more) rely on their affective reactions when confronted with it (Slovic, Peters, Finucane, & MacGregor, 2005).

**Limitations and directions for future research**

Our method for inducing reliance on affect is certainly very direct. More detailed probing on how and why reliance on affect leads to more staying in this type of task is needed. Furthermore, a direct test of emotions that could influence the staying option could be applied. For instance, regret could be hypothesized to influence a person’s choice in such dilemmas and inducing it could certainly offer more support for the affective proposition (Martinez, Zeelenberg, & Rijsman, 2011).

Operationalizing our approach through dual processing theories further expands this theoretical proposition to human processing as well as providing further evidence of attitude construction based on specific systems (Mikels et al., 2011). Nevertheless, we have failed to include a deliberative or rational approach group in our studies. Theoretically, this approach should lead to better results. However, one must be careful with making such claims as the MHD is a complex task and there have been previous studies that suggest that deliberative processing in not particularly suited when dealing with tasks of high complexity (e.g. Wilson et al., 1993).

Although the present research accentuates the negative effects that affect might have on judgment and choice, there are also instances where emotions can lead to optimal decision making. Damasio (1994) goes so far as to say that affect is critical for some decisions. With that in mind, certain lines of research emphasize the potential benefits of the intuitive system in addition to evidence that individuals who have a high level of skill or expertise within a given domain appear to rely to a greater extent on intuitive judgments, implying that intuition is an advanced means of decision making in some contexts (Reyna & Lloyd, 2006). For example, Mikels et al. (2011) have shown that reliance on affect can lead to better choices with complex decisions. On the other hand, research also seems to suggest that for a different subset of tasks, affect can be detrimental (Mikels et al., 2013). Tasks that require some risk seeking in order to maximize profit in the end (Shiv et al., 2005), where it is necessary to understand absolute number bets (Epstein et al., 1996) as well as tasks that do not have a clearly outlined distribution of gains and losses (e.g. the MHD) all present problems for intuitive thinking. This has direct consequences for the model of affect heuristic. For instance, task type certainly has an influence on when reliance on affect is beneficial and when it is not. The affect heuristic model is in much need of extension. For instance, clear mechanisms of affects influence on decision making should be researched. However, not much progress has been made in way of developing a comprehensive framework of affective decision making that includes task features which could provide much needed clarity in this domain.
Conclusion

Interest in emotion has steadfastly gained relevance in decision making studies. This has led to a veritable explosion of work in theorizing and testing about the way emotions can influence, contribute and deter decision making. The MHD has long piqued the interest of decision scientist as it is a perfect example of a task where it is necessary to update one’s prior beliefs to reach an optimal decision. These types of tasks have proven to be extremely difficult for people and have sparked an interest in finding ways to improve and explain the suboptimal performance. The present research suggests that when people are instructed to rely on their emotions it leads them to rely more on a suboptimal strategy i.e. staying with their initial choice in the MHD. These findings could be taken to suggest that a more basic and affective heuristic could be guiding people when they are confronted with tasks that embody a conditional probability structure. Future studies should concentrate toward identifying specific emotional pathways that contribute to this. For instance, isolate specific emotions such as regret to better understand these processes. Similarly, these results could also be taken as first indicators for a need to develop a clear affective model that is focused on tasks that exemplify conditional probabilities since affective reactions could be especially sensitive to the steps needed to make optimal choices recommended by Bayes.

References


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Appendix

Instructions

Today you will be participating in an experiment on decision making. You will be making choices in a multiple trial paradigm. These are the rules: at the beginning of every trial you will be presented with three doors, the prize has an equal chance of being hidden behind each door. You choose one door but they will remain closed for the time being. Afterwards a different door will open revealing nothing behind it, now you have two doors, the one you chose with another one. It is up to you to decide which of the two doors you would like to open. Every time you get the prize you will receive a notification in the form of a green ✔, accordingly, if you haven’t found the prize you will receive a notification in the form of a red X. You will have 60 trials. Try, as best as you can to find as many prizes as you can.