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What drives "Unconscious" Multi-Attribute Decision-Making?

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Abstract

This study aims to further investigate the Unconscious Thought Theory (UTT, Dijksterhuis & Nordgren, 2006), namely whether individual differences account for differences in choice made after either deliberation (conscious thought, CT) or distraction (unconscious thought, UT). Also, subjective weighting was considered and choice options were constructed following individual preferences, hence avoiding choices biased by differences in preferences. The main effect was replicated with a big sample (N=120, CT: 50.8%, UT: 70.5% chose the best alternative), using four different dependent measures. The results show further that the main effect is driven by underperformance of women in the CT condition. Stereotype threat is discussed as a possible explanation.

Keywords: unconscious thought theory; rational decision making; gender differences

Introduction

"All decisions share several common features: They are conscious. They are voluntary. They are intended to bring about outcomes the decision maker prefers over other outcomes." (Yates, 1990, p. 3). All decisions are conscious. But is that true?

Normative Theory

According to normative theories of decision making (e.g. Baron, 2004), people evaluate all options and choose the option with the highest (expected) subjective utility. The goal of every decision is to maximise the expected return and the way to get to this decision is made in rational, hence predictable and consistent, steps (e.g., LeBoeuf, & Shafir, 2005). Expected-utility theory (EUT), for example, states that the expected utility is calculated by multiplying the utility of each possible outcome by its probability and summing across all outcomes (Baron, 2004). Thus, the best decision is the one that yields best consequences over all possible outcomes. However, human subjects show violations from predictions of normative theory.

Violations of Normative Theory

Lichtenstein and Slovic (1971) and Lindman (1971), for example, found a preference-reversal according to two conditions (choice and pricing of two bids, respectively), thus violating the invariance principle. Another example of violation is the framing effect: the same set of information presented differently leads to different decisions (e.g., Tversky & Kahneman, 1981).

Prospect theory (Kahneman & Tversky, 1979; later also cumulative prospect theory, Tversky & Kahneman, 1992), a descriptive model of human decision-making, takes these violations into account. Central to the theory is that utility is measured against a reference point (the current state, and not the sum of all experienced events), thus explaining why behavior changes as the reference point changes. It can also explain loss aversion, i.e., a higher sensitivity to potential losses than to potential gains, which normative theories cannot. In addition, subjects weight the outcomes not by an alternative's objective probability, but by transformed probabilities.

In addition, subjects are bound by several external (e.g. time, information) and internal (e.g. attention, memory capacity) factors (Simon, 1955), thus leading to bounded rationality (Simon, 1956). Especially restrictions in working memory (even more so under time pressure) challenge rationality. In contrast to single-process models (Osman, 2004), dual-process models accommodate for these limitations by treating reason and intuition as two different cognitive modes that lead to different results (e.g. Chaiken & Trope, 1999). Commonly understood, reason (also referred to as "System 2") is effortful and requires conscious evaluation, whereas intuition ("System 1") responds quickly using mental shortcuts (i.e. heuristics, Gigerenzer, 2004). Hence, deliberation is part of reason, while intuition is prone to systematic biases and errors. Ideally, System 2 monitors System 1's decisions and intervenes if necessary.

In multi-attribute decision making–the focus of this study–common heuristics are described as either compensatory or non-compensatory. Compensatory heuristics rely on weighting all attributes (e.g., as a sum of values, choosing the highest; Dawes, 1979), whereas non-compensatory heuristics rely on differences in relation to single cues.

Unconscious Thought Theory (UTT)

The theory of decision-making as presented above, suggests that anything other than dedicated deliberation is an inferior strategy used in limited environments (e.g., time pressure, limited access to information). Deliberation, however does not always lead to the expected best outcome. Wilson and Schooler (1991) found that the rating of a set of jams by non-experts was closer to that of experts when done intuitively than after deliberating the reasons for the rating.

Dijksterhuis and Nordgren (2006), based on earlier findings (Dijksterhuis, 2004; but see also: Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Dijksterhuis & van Olden, 2006), proposed the Unconscious Thought Theory (UTT). UTT states that complex decisions made unconsciously (i.e. when distracted from conscious thought) are more accurate than decisions made consciously (i.e. with effortful thinking about the task at hand). What they describe as unconscious thought is neither 'System 1' nor 'System 2' but lies somewhere in between. Thus, they suggest a 'triad-process model' described as "an effortless route that involves no thought at all, an unconscious route that takes time but is relatively effortless, and a conscious route that is effortful" (Dijksterhuis & Nordgren, 2006, p. 104).

The standard paradigm of the UTT is as follows: In Dijksterhuis (2004), participants were asked to evaluate three or four options (e.g. apartments, room mates; each described with 12-15 features so that one was predominantly positive, one predominantly negative and one or two neutral). One group did so immediately after they had read the descriptions (immediate condition), one after three minutes of conscious thought (deliberation condition) and a third after three minutes of distraction (unconscious thought, distraction condition). The last, Dijksterhuis (2004) argued, was not only distracted but also engaged in unconscious thought, i.e. thinking without attention. The surprising findings showed that those participants engaging in 'unconscious thought' made not only better, i.e. more rational, decisions than those in the immediate condition, but also better decisions than those in the conscious condition (significant difference in Experiments 2 & 3; not significant in Experiment 1).

Critique and Meta-Analysis

The UTT itself is debated in the literature (e.g. González-Vallejo, Lassiter, Bellezza, & Lindberg, 2008; Newell & Shanks, 2014; Payne, Samper, Bettman, & Luce, 2008; Waroquier, et al., 2009). Four meta-analyses have been published so far (Acker, 2008; Nieuwenstein, & van Rijn, 2012; Nieuwenstein, et al., 2015; Strick et al., 2011), with the most recent comprising 61 experiments from 31 studies, showing a small but significant UT effect.[1]

In summary, results of the meta-analyses showed at best a modest benefit for UT. The mechanisms behind the UTT effect, however, are still not sufficiently explained. Several explanations are possible, of which memory effects, weighting and gender differences are part of the current study.

Role of Weighting

Generally, weighting in human judgment is seen as mostly unreliable and highly susceptible to basic manipulations (Shafir & LeBoeuf, 2004), and attribute weights often change systematically despite the normative assumptions that preferences should remain stable (LeBoeuf & Shafir, 2005). Thus, linear models are often seen as normatively better predictions (Dawes, 1979; Dawes, Faust, & Meehl, 1989). Nevertheless, in the fourth principle of UTT, Dijksterhuis and Nordgren (2006) state that in most cases (i.e. when no arithmetic rules have to be followed) UT outperforms CT in consistency and accuracy in accordance with subjective utility.

In most studies, weighting has not been targeted and, where it has, has been done in a pilot study or after the decision task. Dijksterhuis (2004, experiment 3), for example, evaluated the most important attributes in a pilot study and asked participants to rate the attributes according to their individual preference after the decision and a four minutes distractor task. A preference score was calculated for each participant and then correlated with the difference score of attitude in choice with a high correlation showing that the participant chose according to their own weighting. A significant correlation was found for UT ($r[41] = .48$, $p = .002$) but not for CT ($r[47] = .21$, $p = .17$).

However, studies that obtained subjective weighting after the main task comment that rating before the task could possibly increase "the potential for all participants to approach the experiment in a more 'analytic' (conscious) frame of mind, thus […] hampering unconscious thought" (Newell et al., 2009, p. 728). In Aczel, Lukacs, Komlos, and Aitken (2011), however, weighting was done by half of the participants before the main task and again by all participants after the task. In contrast to the Dijksterhuis (2004) findings, they found a significant correlation for CT ($r[24] = .364$, $p = .040$ [one-tailed] but not for UT ($r[24] = .254$, $p = .116$ [one-tailed]).[2]

Gender differences

Amongst the explanations for the variability of the UTT effect, personal differences in general and gender in particular are discussed (Acker, 2008; Nieuwenstein, & van Rijn, 2012). Most commonly, female participants show little or no variation among the UT, CT and immediate conditions (Dijksterhuis 2004, exp. 1 & 3, Thornsteinson and Withrow, 2009, exp. 2). Although significant gender differences have repeatedly been observed, no clear pattern has been found (Nieuwenstein & van Rijn, 2012).

Method

Participants

120 volunteers (Age M = 27.9, SD = 9.10, 42 male, 57.5% English natives, 82.5% students, the majority in undergraduate Psychology courses) from the University of London, Birkbeck College, participated in the experiment.

[1] The effect disappeared when a trim-and-fill procedure was used, as a publication bias was assumed.

[2] Unfortunately, they did not report if there were any differences in choices made by those who rated attributes before and after the task or afterwards only.

Participants received either course credits or a monetary reward (£5). Ten participants reported some form of impairment[3] at the start of the experiment, but did not report any problems during the trial. The main effect did not change when these participants were excluded (if anything, exclusion favoured the UT effect). Thus, it was decided not to exclude those participants, but, where relevant, results are presented including and excluding those ten participants.

Design

Participants were randomly assigned to one of six conditions in the 2 x 3 factorial design[4].

Material

The attributes used for the experiment were aspects that were deemed relevant when applying for a university. From a total of 58 different attributes acquired in a pilot study, the 20 most frequently reported were chosen for the experiment. Four universities were constructed with 12 attributes each, differing in number of positive and negative attributes, as defined by the participant. A was the most positive with 8 positive and 4 negative attributes, D was the reversed and B and C both had 6 positive and 6 negative attributes, with B taking the top 6 as positive attributes and C taking the top 6 as negative attributes.

Procedure

All participants were tested individually in the testing room. At the start of the experiment, the purpose of the study was explained and written informed consent obtained. A short questionnaire about demographics was filled in by experimenter and participant together.

The actual experiment was divided into two parts with three distractor tasks in between. In the first part, the participants were asked to rank-order the 20 attributes describing general aspects of universities from most to least important, according to their own judgment. The order was the basis for the second part and entered into the computer while participants were occupied by the third distractor task.[5] All three distractor tasks are highly demanding, thus suitable as distractor tasks. Including instructions, they took up only about ten to 15 minutes and hence did not tire the participants.

In the second part of the experiment, participants were made familiar with the names of four fictional universities. They were instructed that each university would be described by 12 attributes, appearing one by one on the screen in random order. The instruction was to memorise the attributes as well as possible, so as to make a good decision later on. The attributes were then presented on screen, for 4s each with 0.5 seconds interval in between (4 x 12 x 4.5 sec = 3 min and 36 seconds in total). Then, the participants either had three minutes to think about the attributes (deliberation condition), or had to come up within three minutes with as many answers as possible to the question “What could you do if you were invisible?” (distraction condition). Finally, participants were asked to order the universities from best to worst choice.

Statistical Analysis

The chosen order of the universities is recorded for rationality of choice. Hence, the percentage of participants choosing the best option as the first (and the worst as the last) can be reported. χ^2-tests and binominal tests are performed to assess group differences and chance level (two-tailed). Furthermore, the steps necessary to get from the participants choice to the optimal choice (A-B-C-D; e.g. 6 steps for D-C-B-A and 3 steps for C-B-A-D, respectively) as well as the number of positive attributes for the first choice can be calculated and represent measures of rationality. T-tests as well as ANOVA and post-hoc t-tests (Bonferroni correction) are performed.

Regarding weighting, the percentage of participants choosing option B over option C is reported. This measure is regardless of option B being the first, second or third choice, as long as it comes before C. χ^2-tests are performed to assess group differences.

Results

UTT Effect

Best Option as First Choice

The percentage of participants choosing the best option as the first (A=1st Choice) is 50.8% for CT and 70.5% for UT. This difference is significant for the whole sample (χ^2[1, 120] = 4.858, p = .028) and stronger with participants with impairment excluded (χ^2[1, 110] = 6.571, p = .010).

Number of Positive Attributes of the First Choice

The first choice made by participants in the UT group had on average more positive attributes than in the CT group (M=6.78, SD=1.390 and M=7.34, SD=1.078, respectively; p=.015).

Choice order

Participants needed on average M=1.38 (SD=1.445) moves to get to the optimal order A-B-C-D. In total, one third (30.0%) of the participants found the rational order of A-B-C-D, another third (35.8%) needed one move to get to this

[3] i.e., Dyslexia, migraine, epilepsy, hearing impairment.

[4] A memory manipulation was included, but due to space limitations results are not reported here. Therefore, only differences between UT and CT groups are considered in the remainder (N =120).

[5] The first distractor task was the Animal Fluency Task, a variation of the Verbal Fluency Task (Bousfield & Sedgewick, 1944). For 120 seconds participants had to name as many animals as possible. The second task was a Random Number Generation task (Wagenaar, 1972). Here, participants had to say digits from 1 to 10 in random order, one a second for 100 seconds in pace with a metronome. The third task was a sheet with 24 reasoning puzzles assessing verbal problem solving ability. Participants had to find one of three or four objects with a certain attribute (e.g. “Jamie ate less than Susan, but Neal ate more than Susan. Who ate the least?”). The time limit was set at five minutes and the instruction was to do as many puzzles as possible.

order, the remaining needed two or more moves. Of those needing one move, the order B-A-C-D was the most common (41.9%), followed by A-B-D-C (37.2%).

Participants in the CT group were on average more moves away from the rational order of universities than participants in the UT group (M=1.63, SD=1.553 and M=1.15, SD=1.302); this difference is significant when participants with impairments are excluded (t[94] = 2.241, p = .027; M=1.60, SD=1.594 and M=1.02, SD=1.080, respectively).

Choice according to subjective utility

In the CT condition, participants chose according to their own weighting preferences (78.0% chose B over C) not differently than in the UT condition (77.0% chose B over C; χ^2[1, 120] = 0.014, p =.904). There are no significant differences between those participants who made the best choice (A=1st Choice; CT: 73.3%, UT: 79.1%) and those who made an inferior choice (χ^2[1,120] = 0.066, p = .797).

Chance level

All four measures in both groups were significantly different from the chance levels (all binomial and t-tests p < .01).

Individual Differences

Of all individual differences (age, first language, student/employment, course [if applicable], ethnicity, handedness), only gender showed an effect and is discussed in the following.

Gender

There was a tendency for male participants to decide more rationally (71.4% vs. 55.1%). This is, however, not significant (χ^2[1]=3.044, p=.081). In detail it can be seen, that (1) female participants did better in the UT than in the CT condition regarding A=1st choice (70.0% vs. 39.5%, χ^2[1,120] = 7.341, p = .007), number of positive attributes (M = 7.30, SD = 1.159 vs. M = 6.53, SD = 1.370, t[76] = 2.685, p = .009) and necessary moves (M = 1.05, SD = 1.037 vs. M = 1.74, SD = 1.622, p = .03), but not regarding B before C; (2) Male participants did equally well in both thought conditions (both 71.4%). Thus, the UTT effect is solely driven by female participants. In the UT condition, men were at chance in choosing B over C, but required fewer moves to get to the correct order.

Discussion

This study replicated the UT effect in a large sample where each participant weighted attributes individually, ensuring options were the best or worst according to both objective and subjective standards. Gender had an effect on the rationality of decision-making.

UT effect

In this study, a significant UT advantage was found on all three measurements used (but there was no difference in choice according to subjective utility). This result is remarkable insofar as Nieuwenstein and van Rijn (2012) in their meta-analysis only found an effect when CT was at chance level. Here, however, both conditions are above chance level and significant on more than one measure.

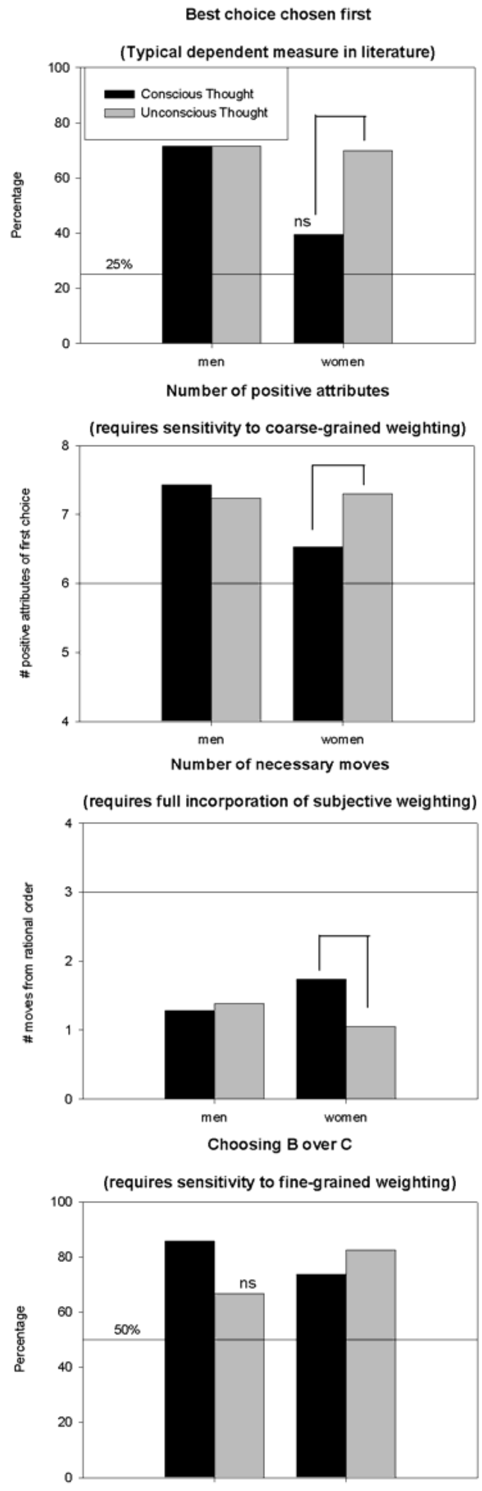

Figure 1. Results across all groups and gender. Within-gender UT effects are indicated by the comparison lines. “ns” indicates that the group is not different from the horizontal chance level.

Also, attributes match the subjective preferences, which undermines previous critiques that results were distorted by differences in individual and objective choice.

One possible explanation for this discrepancy is that long deliberation time might enhance interference in the CT group and that Nieuwenstein and van Rijn (2012) did not find an effect because of their short deliberation time.

Weighting

Thought (77.0% vs. 78%) had no effect on choice according to subjective utility. However, a pattern in the number of necessary moves can be found linked to subjective utility: participants who needed only one move (a third), most often switched between A and B (B-A-C-D, 41.9%) and C and D (A-B-D-C, 37.2%). This indicates that it was harder to distinguish between A and B, and between C and D, respectively, than between B and C where the only difference was the subjective preference. Although research shows that consistency and variability of preference change when participants think about their attitudes (Levine, Halberstadt, Goldstone, 1996; Wilson, Dunn, Kraft, Lisle, 1989), taking subjective weighting into account reduces the risk of a distorted choice.

Gender

In this study, the basic UT effect can be attributed to the effect of gender, i.e. male participants did not show a difference between conscious and unconscious thought (both 71.4%), whereas female participants responded strongly to the thought manipulation (CT: 39.5%, UT: 70.0%), with CT not different from chance level. This is in stark contrast to previous findings (Dijksterhuis, 2004; Thornsteinson & Withrow, 2009, Nieuwenstein & van Rijn, 2012), where male participants showed more variable results and females performed consistently well.

Women in the CT group also chose an option with fewer positive attributes than women in the UT group. It appears that women in the CT group underperformed, while there were no differences amongst the other groups. One possible explanation is that women's performance was impaired by a phenomenon called stereotype threat. Stereotype threat states that if for a specific group a negative stereotype exists and is triggered, it leads to underperformance of this group due to anxiety that one might confirm the stereotype (Steele, 1997). It has been observed for women and the negative stereotype that they are less gifted in mathematics (Spencer, Steele, & Quinn, 1999). Here, stereotype threat might have been triggered by asking for a rational choice (study advertising and instructions) with the background of women being seen as 'irrational' deciders, i.e. as following intuition at the cost of rationality. Stereotype threat was long believed to impair working memory. Recent research, however, suggests that mere effort accounts for the difference in performance, i.e. the participant under threat tries harder and thus relies on effortful mental processes rather than learning alternative, more efficient strategies (Jamieson & Harkins, 2007; Rydell, Shiffrin, Coucher, Van Loo, & Rydell, 2010). Making a decision based on all 48 attributes presented is a keen but virtually impossible task and hence heuristics are a more efficient alternative (Gigerenzer, 2004) that women in the CT group were presumably not willing to take due to stereotype threat. For further research it is suggested that the focus turn to the exact strategies participants use to come to a decision and how these interact with individual differences.

Although women in the CT seem to underperform, men in the UT group were insensitive to the subjective weighting, suggesting that gender and distraction influence the type of decision-making strategy.

Strengths and Limitations

One limitation of this study is that assessing subjective preferences before the task, despite the distractor tasks, might have changed the mind-set of participants. As discussed above, alternatives are possible and should be considered for further investigation. Under the present circumstances, however, this approach addressed the importance of subjective weighting with the least interference.

The strength of this study is a replication of the main effect with a bigger sample using *several* measures. Also, construction of the four options according to individual weighting should have lead to less biased results. Based on the findings here, further research should focus on (1) whether the UT effect shows under certain circumstances, (2) what the mental steps are on which the choices are based, e.g. which heuristics are used during encoding, and (3) how decision making interacts with individual differences.

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