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ABSTRACT

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In this study we test predictions from Unconscious Thought Theory (UTT) that unconscious thought will lead to better decision making in complex decision tasks relative to conscious thought. Different from prior work testing this prediction, we use a method of manipulating conscious and unconscious thinking that is free from distraction. Specifically, we use a 3-week protocol to experimentally induce adverse sleep and circadian states, both of which should reduce deliberative, conscious thinking and therefore increase the relative importance of more automatic unconscious processes. Our findings fail to support UTT predictions and instead coalesce with other replication attempts that cast doubt on the superiority of unconscious processing in complex decision making.

JEL Classification: C91, D03

Keywords: sleep restriction, circadian, complex decisions, decision making, unconscious reasoning, sleep, experiments, behavioral economics

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Is it better to give more or less conscious thought to complex decisions? This is an important question given the multitude of important and complex decisions made every day. One theory specifically designed to address this question is Unconscious Thought Theory (UTT, Dijksterhuis & Nordgren, 2006). UTT proposes a counterintuitive and fascinating answer to this question; *less* conscious thought actually leads to *better* decision making in complex tasks.

According to UTT, human consciousness has a limited capacity for processing information, including decision-relevant information. Conversely, the unconscious has a capacity that far exceeds that of consciousness, perhaps even unlimited. Therefore, when making complex decisions, a person's performance will be maximized when the superior capacity of the *unconscious* is utilized rather than the limited consciousness.

Initial work seemed to provide strong evidence for the superiority of unconscious thought in complex decisions (e.g., Dijksterhuis, 2004; Dijksterhuis, Bos, van der Leij, & van Baaren, 2009; Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Dijksterhuis & Meurs, 2006), showing consistent but not always robust effects. However, later attempts at replication and reanalysis of the methodology used to test UTT has drawn debate concerning the validity and legitimacy of the findings (e.g., Acker, 2008; Calvillo & Penaloza, 2009; Mamede et al., 2010; Newell, Wong, Cheung, & Rakow, 2009; Thorsteinson & Withrow, 2009; Waroquier, Marchiori, Klein, & Cleeremans, 2010).

In a meta-analysis of seventeen studies that were similar to the Dijksterhuis et al. (2006) study, Acker (2008) found very limited evidence to support the prediction that unconscious thought improves performance for complex decisions. Further, Newell & Rakow (2011) analyzed sixteen UTT studies using Bayesian *t* tests and found no support for the proposition that unconscious deliberation improves performance on complex tasks. Contrary to this finding, Strick et al. (2011) argued in a separate meta-analysis that UTT effects are real and that the contradictory findings are due to differences found among the various studies.

The debate over the validity, methodological acceptability and replicability of the UTT effect remains contentious but with persistent support (e.g., Dijksterhuis, van Knippenberg, Holland, & Veling, 2014) amid mounting evidence to the contrary (see Newell, & Shanks, 2014). The point of the current paper is to contribute additional evidence to this growing body of literature by offering an additional test of the deliberation-without-attention effect using a different methodological procedure that is arguably more naturalistic and externally valid than many existing approaches to promoting unconscious reasoning.

A fundamental procedural component found across the existing experimental investigations of UTT is to restrain or redirect the conscious thought that would otherwise focus on the decision task. This is done ostensibly to distract consciousness and prevent it from "thinking" about or processing the decision. It is assumed that when consciousness is distracted, the unconscious will take over and process the decision task. In this method participants are directed to work on some type of thoughtful task. For example, one type of task commonly used is solving anagrams.

One inherent aspect of these types of manipulations is that using cognitive distraction to avoid conscious thought will likely affect subsequent cognitive processing in some way. More specifically, when these types of distraction procedures are used it could potentially deplete cognitive resources for the next task, prime thinking processes, lead to memory interference or have some other unknown influence (For examples see Lassiter, Lindberg, Gonzalez-Vallejo, Belleza, & Phillips, 2009; Payne, Samper, Bettman, & Luce, 2008; Rey, Goldstein, & Perruchet, 2009; Shanks, 2006). From our perspective, what is relevant is that this methodology may be inducing something other than a distraction from consciousness. Importantly, it could be that other "something" that is leading to any observed effects rather than the distraction of consciousness *per se*. So, because this issue is inherent to the distraction methodology commonly used, it is particularly important to test UTT predictions using different methodological procedures, ideally using a procedure that can avoid the distraction procedural issues. In this way, we hope to contribute to a more complete understanding of the viability of UTT.

In the current study we employ a methodology that is free of the effortful cognitive tasks commonly used to test the deliberation-without-attention effect. To accomplish this, we manipulated the variables of sleep and circadian match. Specifically, under conditions of sleep deprivation and/or circadian mismatch (i.e., suboptimal times of day given one's diurnal preference) conscious processing should be inhibited and unconscious processing more likely to occur. Under conditions of well-rested and/or circadian match, conscious processing should be relatively more likely to dominate decision making.

Based upon this reasoning, we hypothesized from UTT that when conscious resources are constrained through sleep deprivation and circadian mismatch, participants will perform better on complex tasks because they should be more likely to utilize unconscious processing. Conversely, when participants are well rested and circadian matched, they should perform more poorly because they will be more likely to process the complex decision with thoughtful, conscious processing.

Method

Participants

In order to test our hypothesis, we initially attempted to recruit 256 participants from a large database of local respondents to an online survey[1]. From this initial recruitment group, 35 failed to show up for the initial introduction session (Session 1) and 37 of the participants failed to complete the prescribed protocol at some point during the three-week period and were removed from the study. Therefore, a total of 184 participants took part in the study for the entire three weeks. Actigraphy malfunction occurred for 9 of the participants and their data was not retrievable so their responses were not included in the study. Of the 175 participants, 149 met the criteria for being sleep compliant[2] and 140 of them completed the decision tasks correctly and had retrievable data (n=30 control participants, n=110 treatment participants). Among the 140 participants, 88 of them were female and 52 were male. Participants ranged in age from 18-40 (M age = 21.9).

Apparatus and materials

To measure participant's sleep/wake times across the three-week period of our study we used an experiment grade Actigraphy acquisition device (Actiwatch Spectrum Plus devices; Philips Respironics). The actigraph uses an MEMS type accelerometer and samples data at 32

[1] For a more in depth analysis of attrition, compliance, and validation of the protocol used in this study see Dickinson, Drummond, & McElroy (2016).

[2] In order to be sleep compliant a subject must have at least 60 minutes or more of nightly sleep during the well-rested week than the sleep-restricted week.

Hz. For our experiments, we set devices to sample activity at 30-second epochs. The actigraph is waterproof and participants were instructed to wear them at all times during the course of the three-week study unless they were engaging in activity that might harm the device. The actigraphy device records wrist movement as a proxy for gross motor movements and is well-validated in use with non-sleep disordered subjects (see Sadeh, 2011, for a discussion of actigraphy validity and limitations). Device software automatically scores each epoch as “sleep” or “wake”, but scoring the beginning/end points of a subject’s attempted rest period is done manually in conjunction with sleep logs kept by subjects.[3] All manual scoring was done using a common sleep research actigraphy scoring protocol (Goldman et al., 2007).

Procedure

An online survey was widely circulated around a campus community to create a sizeable pool of participants for possible recruitment in our study. Participants who completed the survey were entered into a drawing for a gift card. Over the course of multiple academic semesters several thousand people responded to the survey. Respondents were mostly university students. The survey asked basic demographic information as well as validated screener questions for anxiety and depression.

Central to our survey was a validated measure of circadian preference, the short form of the morningness-eveningness questionnaire (rMEQ) (Adan & Admiral, 1991). The rMEQ is a shortened version of the Horne and Östberg (1976) scale. The rMEQ is designed to rank individuals on a range from 4-25, with morning-types scoring from 18-25 and evening-types

[3] For example, manual scoring also allows the researcher to dictate that specific time period with little or no activity is counted as “wake” by the software. Such would be the case if the subject indicates that he/she removed the watch to play contact sports for a couple of hours, for example.

scoring from 4-11. This circadian preference measure has been well validated (Adan & Admiral, 1991; Horne & Östberg, 1976) and is standard in circadian research.

After a sizable database was established we began recruiting morning-type[4] and evening-type subjects (intermediate-types were used as control subjects). Because of the association between anxiety, depression and sleep disturbance, individuals scoring at risk for either major anxiety or depressive disorder were omitted as possible participants in the study, as were those who reported a diagnosed sleep disorder. Both morning-type and evening-type participants were randomly assigned to either the early morning (7:30am-9:00am) or late evening (10:00pm-11:30pm) session time. Approximately half the sample was circadian matched and half mismatched and, importantly, these random session time assignments were done prior to recruitment to the main 3-week study. Subjects were only offered to participate in a session time to which they were randomly assigned, which helps avoid subject self-selection into preferred session times.

The main protocol in this study was three weeks long, and included three in-lab sessions, all taking place at the same session time. For example, one cohort (group) would be an Evening Session group, with all sessions being in the evening, although the cohort would be comprised of a mix of morning-types and evening-type subjects. All participants first met in the laboratory (Session 1) to be introduced to the experiment. During this session they were assigned random subject numbers and actrigraphy devices, instructed on how to do morning and evening call-ins (another way we helped ensure accurate bed/wake times for scoring), sleep diary recording, and

[4] Because legitimate morning-types are infrequent in subject populations, usually less than 10%, we included rMEQ scores as low as 17 as morning types (i.e., Intermediate-types that are close to being categorized as morning-types). Evening-type rMEQ scores recruited ranged from 4-9.

they were informed more specifically about monetary compensation for participation in the study.[5] The specifics on the timeline of the protocol are shown in Figure 1.

During week 1 participants in the treatment conditions were prescribed either one week of Sleep-restriction (SR) (5-6 hrs./night attempted sleep) or one week of Well-rested sleep (WR) (8-9 hrs./night attempted sleep), with order counterbalanced across groups. Participants in the control groups were prescribed WR weeks in both experimental weeks. At the end of week 1 participants returned to the lab for Session 2 at the same session time-of-day as Session 1.[6] During Session 2 participants were presented via computer the complex decision task taken from Dijksterhuis, et al., (2006). This task involved choosing among four computers that had 12 attributes, all of which were balanced for valence. Before presentation, participants were informed about the nature of the decision task and the monetary incentive. Specifically, they were told "You will be rewarded $5.00 if you choose the best product." The complex decision tasks consisted of choosing between either four cars or four computers, where each of the cars and computers possessed 12 attributes for comparison and balanced for valence.

Week 2 of the 3-week protocol was an ad lib sleep week, and subjects did not return to the lab after week 2. This week was included to wash out the effects of the week 1 treatment (either SR or WR) prior to administration of the opposite sleep prescription (WR or SR, respectively) in week 3. At the end of week 3 was Session 3, during which subjects were administered the second version of the complex decision task. In this way, each subject will be prescribed one WR and one SR week, such that we have repeated measures data from subjects

[5] The basics of the experiment protocol, including compensation, was also discussed and summarized for subjects in the recruitment email they initially received. Subjects received a fixed $80 payment for compliance with the parameters of the 3-week protocol and provision of the actigraphy and diary data. Additional compensation was earned during Sessions 2 and 3 for certain decision task experiment outcomes.

[6] Control subject sessions took place between 10am and 3pm, as the intention was to remove the circadian and sleep-restriction elements from the design for the small set of Control subjects.

regarding sleep level, but between-subjects data regarding circadian match or mismatch. We communicated with subjects every 2-3 days of the 3-week protocol to remind them of the current sleep prescription (which included a cautionary message if in the SR week due to the risk of drowsiness) and reminders of when the upcoming in-lab sessions would take place.

Results

The purpose of this study was to test whether unconscious thinking would lead to better performance in complex decision tasks. Table 1 shows mean values of the correct response indicator (1=correct, 0=incorrect) in each treatment condition. Tables 2 and 3 show means by experimental session (1^{st} versus 2^{nd} administration of the task). To test our hypothesis, we first performed an ANOVA with Sleep Level (SR vs WR) as a within variable and Circadian Match (Matched vs Mismatched) as a between variable and participant's performance on the complex decision task as our dependent variable. In this analysis we also included the order of sleep manipulation as a variable to test whether the counterbalancing of conditions had an effect on responses. This analysis did not reveal a significant effect for order of sleep manipulation when the control group was included F (1, 135) = .97, $p < .098$, ηp2 = .83 or removed F (1, 106) = 1.04, $p < .32$, ηp2 =.010[7]. Therefore, we removed this variable from future analysis. Next we performed the analysis with Sleep Level as a within and Circadian Match as a between variable. This analysis revealed a non-significant main effect for Sleep Level F (1, 137) = .32, $p < .58$, ηp2 = .002, a non-significant main effect for Circadian Match F (1, 137) = .18, $p < .84$, ηp2 = .003 and a similar non-significant interaction of F (1, 137) = 2.8, $p < .098$, ηp2 = .025. Similar results were found when we removed the control and only compared the experimental groups,

[7] No other main effects or interactions were significant with the inclusion of the order variable.

yielding a non-significant main effect for Sleep Level F (1, 108) = 2.8, $p < .098$, ηp2 = .025, a non-significant main effect for Circadian Match F (1, 108) = .344, $p < .56$, ηp2 = .003 and a Sleep Level X Circadian Match term of F (1, 108) = .0, $p < .9$, ηp2 = .0.

Conclusion

We approached our question of consciousness and complex decision making from a purely empirical standpoint. We formulated a hypothesis from UTT. We then noted both sides of this controversial question and took an objective approach to testing the hypothesis. Our findings failed to support the UTT proposition that unconscious thinking will lead to better complex decision making than conscious thinking. In fact, similar to others (see Newell & Shanks, 2014), our findings lean towards the opposite result.

A danger lurking in many disciplines is the quick ascension to prominence of counterintuitive and catchy findings. Recently there has been a great deal of debate about this within the area of psychology. Like others, our data support a more intuitive and simple truth; less attentive thought does not lead to better complex decision making. Rather, the data seem to suggest that more attentive, conscious thinking leans towards better complex decision making.

The latter point is not simply post-hoc conjecture, it represents a traditional view in the area of Judgment and Decision Making (e.g., Kahneman, 2011; Payne, Bettman, & Johnson, 1992; Reyna and Brainerd, 1995; 2011; Simon 1957). Together these views coalesce around the theme that effortful, attentive thinking (i.e., more conscious thinking), will lead to better complex decision making in most decision-making situations. Of course, many factors can deflate the benefit of more conscious effort (i.e., overthinking), yet, that does not necessitate a superiority of unconscious thought, it merely suggests that it has limitations. This proposition is not catchy but it is sound and has more thoroughly stood the test of replication in numerous decision making contexts.

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Tables

Table 1

Means and SDs of participant responses to the complex decision task.

	Sleep Condition					
	Sleep-deprived			Well-rested		
Circadian	M	N	SD	M	N	SD
Match	.75	56	.44	.82	56	.39
Mismatch	.70	53	.46	.79	53	.41

Mean and SD of participants in control group

	M	N	SD
Control	.8	30	.41

Note: Correct responses were coded as "1" all incorrect responses were coded as "0".

Table 2

Means and SDs of participant responses to Task 1— administered in the 1st Decision Session.

	Sleep Condition					
	Sleep-deprived			Well-rested		
Circadian	M	N	SD	M	N	SD
Match	.74	27	.45	.90	29	.31
Mismatch	.64	25	.49	.79	28	.42

Mean and SD of participants in control group

	M	N	SD
Control	.8	30	.41

Note. Correct responses were coded as "1" all incorrect responses were coded as "0".

Table 3

Means and SDs of participant responses to Task 2—administered in the 2nd Decision Session session.

	Sleep Condition					
	Sleep-deprived			Well-rested		
Circadian	M	N	SD	M	N	SD
Match	.76	29	.44	.74	27	.45
Mismatch	.75	28	.44	.80	25	.41

Mean and SD of participants in control group

	M	N	SD
Control	.7	30	.47

Note. Correct responses were coded as "1" all incorrect responses were coded as "0".

FIGURE 1: Protocol Details and Timeline

SR treatment week = prescribed 5-6 hr/night in bed attempting to sleep, naps discouraged. Sleep diaries kept.
WR treatment week = prescribed 8-9 hr/night in bed attempting to sleep, naps discouraged. Sleep diaries kept.
Ad lib sleep week = subject sleep however much/little they like. Sleep diaries kept.
Sessions: Subjects come to research lab in each instance.