EFFECTS OF DISSONANCE AND DISRUPTION ON RISKY DECISIONS

by

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Abstract

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All choices develop first from the basic sensory stimuli to which our systems attend, consciously and unconsciously. The cognitive processes which form the basis of decision- making and contextual shifting require attention to both novel and familiar environmental features; from the overwhelming stimulus that assault our senses, we must figure out which environmental features are safe to ignore and those to which we must attend. Separate fast, emotional and slower rational decision processes described by a number of dual-processing theories have found compelling support in neuroscience research examining selective attention gating mechanisms. Indeed, these two systems appear to exert substantial influence over attentional mechanisms; therefore any interplay between these systems is of great interest.

Ideally, people need to be able to handle uncertainty and pressure while benefiting from heightened emotional, intuitive quickness, associated with clear survival implications, without losing access to their slower reasoning mechanisms due to overwhelming emotional or environmental stimuli ; that is, if they are to make truly optimal decisions in changing contexts. An increased understanding of how these processing systems influence human attention mechanisms would therefore contribute to efforts to improve decisions, especially quick decisions. Furthermore, a better understanding of how to actively up- and/or down-regulate these systems could prove both informative and valuable.

The current behavioral research aimed to test some of the implications of the proposed relationships between several brain areas related to selective attention by examining behavioral evidence of dual-processing. The purpose of this study was to examine the effects of cognitive disruption and cognitive dissonance on performance of a simulated gambling task known to elicit both emotional, system-1 processing, as well as rational, system-2 processing. Results failed to support my predictions. Limitations and implications for future research are discussed.

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Chapter 1

Introduction

Each day we are faced with an array of environments, each with its own set of behavioral rules, problems, and challenges; most day-to-day experience requires varying levels of quick and slow decisions. The ability to inhibit automatic, instinctual, or habitual responses and to devote resources (time, energy, and attention) to thoughtful consideration--in the proper context--is crucial to successful navigation of an ever-changing environment. The cognitive processes which form the bases of contextual shifting and decision strategies require conscious and unconscious attention to both novel and familiar environmental features. From the constant, often chaotic, stimuli that assault our senses, we must figure out which features are safe to ignore and those to which we must attend. And since all choices, both conscious and unconscious, develop first from the basic sensory stimuli to which our systems attend, the interplay between fast, intuitive and slow, rational processes and their influence over selective attention mechanisms is of great interest.

Dual-processing

Daniel Kahneman has described a dual-processing, decision-making system that includes an emotional, intuitive, "system-1" process which is thought to be automatic, associative, and heuristic-based and is difficult (though not impossible) to change, as well as a reasoning "system-2" which is slower, conscious, judgment-based, and that has considerable plasticity (Kahneman, 2003; 2011). At one time dual-processing systems were thought to simply compete but current, scientifically based efforts to describe the human decision-making process have come to view these systems as heterarchies (unranked systems), rather than hierarchies (Levine, 2007). Indeed, recent neuroscience findings provide supportive evidence for the existence of separate rational and emotion systems.

Neural imaging research has identified two distinct learning/processing systems that are indeed in line with previous theoretical, physiological, and behavioral observations supporting dual-processing theories (Gläscher, Daw, Dayan, & O'Doherty, 2010; Haith & Krakauer, 2013). Haith & Krakauer (2013) showed two processing systems that direct human behavior. They have described a “model-free system” which relies upon accepted learning and trial-and-error comparisons that is fast, highly automated, and repetitive. This system is thought to be used for every day, moment-to-moment life, similar to descriptions of quick, intuitive, emotional, system-1 processing (Gläscher et al., 2010; Haith & Krakauer, 2013). Their “model-based system,” is slow, flexible, and analytical, and uses the amount of surprise in a situation to update expectations and to make better predictions. This system is thought to be used to deal with unexpected and/or complex situations, similar to descriptions of slow, rational, reflective, system-2 processing (Haith & Krakauer, 2013). These systems learn and act in parallel and are considered both complementary and redundant (Haith & Krakauer, 2013). Cooperation and attentional competition between the two allow for flexible decisions in an unpredictable, changing environment, to produce optimal decision-making.

Selective Attention and Gating Mechanisms

How our brain sorts through tremendous amounts of sensory input and then chooses which features are most important, and require attention, is clearly complicated; however, a great deal is known about how the brain processes all this information. Sensory input is thought to pass through an array of thalamic “gates” before even being relayed out to the cortex (Gray, 1997), meaning for example, after light has entered they eye and hit the retina --but before the visual cortex has “seen” the image-- the thalamus has already made a rough threat assessment and activated (or not activated) an immediate motor response. This is what has happened the moment someone begins flailing around after walking through a spider web. In the presence of a real or even perceived danger, the thalamus is able to activate a reflexive, motor response because of neural projections directly between the thalamus and the motor cortex (Gray, 1997). However, beyond this protective, reflexive activation, the thalamus also sits at the very center of selective attention gating mechanisms.

Thalamic Reticular Nucleus (TNR) Gating.

While there are a large number of neural projections that send sensory information from the thalamus out to all the primary cortices, there are an even larger number of sensory connections from every region of the cortex sending processed information back toward the thalamus, converging at the thalamic reticular nucleus (TRN) which wraps around it like a thin shell (Gray, 1997; Newman & Grace, 1999). Lying between the thalamus and the cortex, the TRN receives projections from all cerebral cortices, yet it only sends inhibitory signals to the thalamus (Zikopoulos &

Barbas, 2012). This places the TRN in a position to act as an early filter for sensory signals, as a gate for thalamo-cortical communication, and as a key area for the integration of both bottom-up and top-down sensory signals. The dorsolateral prefrontal cortex (DLPFC) and posterior orbitofrontal cortex (pOFC) are thought to control how signals pass through the thalamus to direct attention through connections with the TRN (Zikopoulos & Barbas, 2012).

Emotion. The amygdala is known as a key structure involved in the processing of emotional information, specifically emotional valence. Based on the extensive, robust connections between the amygdala and the pOFC (shown in Figure 1), converging at the TNR, Zikopoulos & Barbas (2012) have suggested this is an integration site where amygdalar and prefrontal signals attend to emotionally salient stimuli, assess their value, and determine if the information should be passed on to the cortex. Indeed, the extensive neural overlap at these TRN convergence sites provides a mechanism within selective attention nodes to deal with highly complex affective stimuli, as well as for rapid shifting to important affective stimuli (Zikopoulos & Barbas, 2012).

Cognition. The highly innervated TRN is also richly connected with the hippocampus (Gray, 1997; Zikopoulos & Barbas, 2012), see Figure 1. The dense collection of high-level processing signals from the cortices which converge with hippocampal connections at the TRN suggests it as an integration site for rational processing as well, with a surprising degree of top-down control over the TRN gates (Newman & Grace, 1999). Newman and Grace (1999) have pointed out that full conscious recognition of any external sensory stimulus occurs only after the stimulus has been processed through a succession of brain areas. For example, once a signal from the retina has reached the primary visual cortex, it generates a very rough sketch of the image and then characteristics such as color, motion, and dimensionality are factored in at higher processing levels; all of which ultimately feed into the infero-temporal cortex (Newman & Grace, 1999).

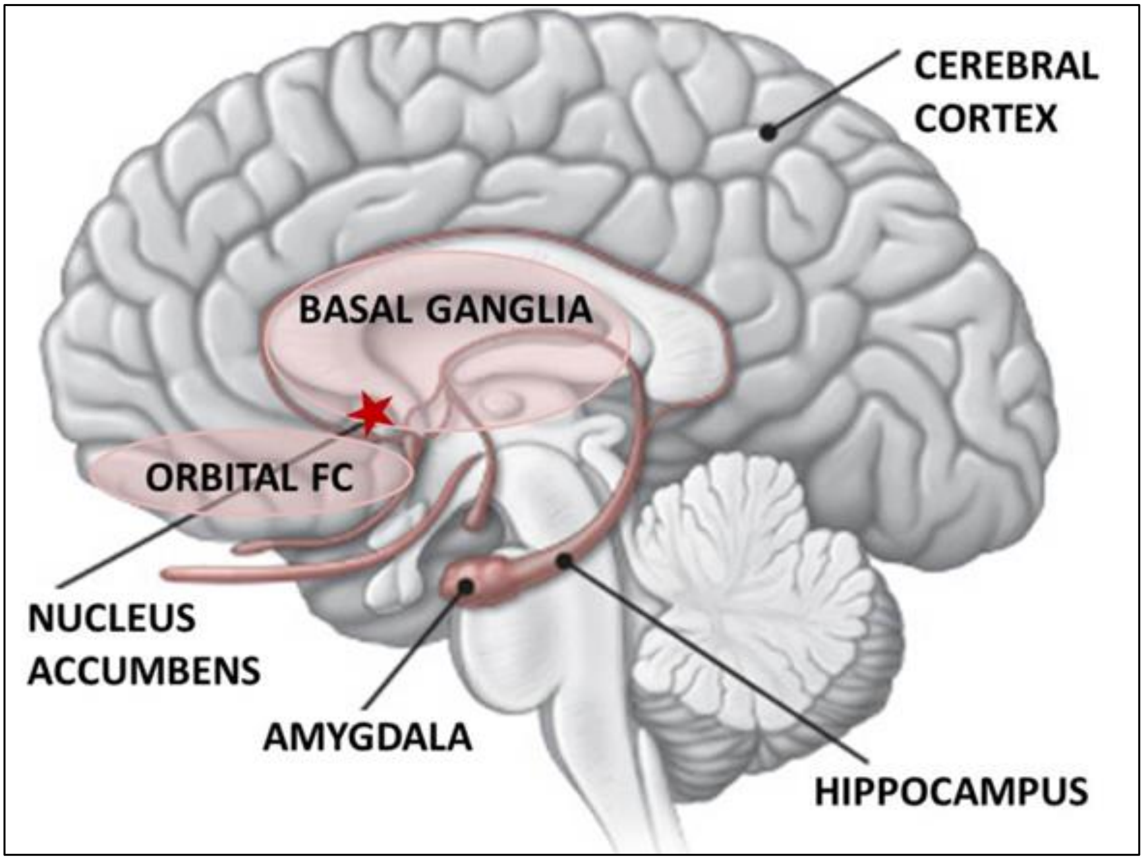


Figure 1. Illustration of brain areas related to selective attention. Basal ganglia are considered a site of both reward influence and habit formation. Nucleus accumbens acts as a selective attention gating mechanism, where motivational and motor systems are simultaneously processed. The hippocampus records memories of experiences and the amygdala creates conditioned responses to certain stimuli. Retrieved November 1, 2014 fromhttp://www.health.harvard.edu/newsletters/Harvard_Mental_Health_ Letter/2011/July/how-addiction-hijacks-the-brain. Copyright (2011) by Scott Leighton. Adapted with permission.

The infero-temporal cortex and hippocampus are also highly interconnected and have long been implicated in the consolidation of working memory: however, the infero-temporal-hippocampal system is thought to also be involved in processing contextual information (Newman & Grace, 1999).

Highly processed sensory information from all over the brain is fed to the hippocampus from a slow, higher-processing pathway. It is thought that the hippocampus takes this high-level sensory input and then compares and contrasts the properties of the current experience with previous experiences to generate a sense of familiarity or non-familiarity based upon how much the experience matches or violates previously learned contexts (Newman & Grace, 1999). Gray (1997) went so far as to suggest it is this hippocampal comparator system that generates the contents of consciousness itself.

Nucleus Accumbens (NAc) Gating.

Another equally important structure related to selective attention is the nucleus accumbens, located in the basal ganglia (see Figure 1), which also shares connections with the TRN. As a rare area in which motivational and motor systems are processed simultaneously, and as a site of midbrain dopamine production, this is thought to be a site of reward influence and habit formation (Newman & Grace, 1999). Newman & Grace (1999) identified three similar major influences on nucleus accumbens selective attention gating activity: the hippocampus (related to context), the prefrontal cortex (related to motor & planning), and the amygdala (related to emotional valence), see Figure 2. Additionally, the link between the hippocampus and the TRN is thought to be mediated by the nucleus accumbens (Newman & Grace, 1999).

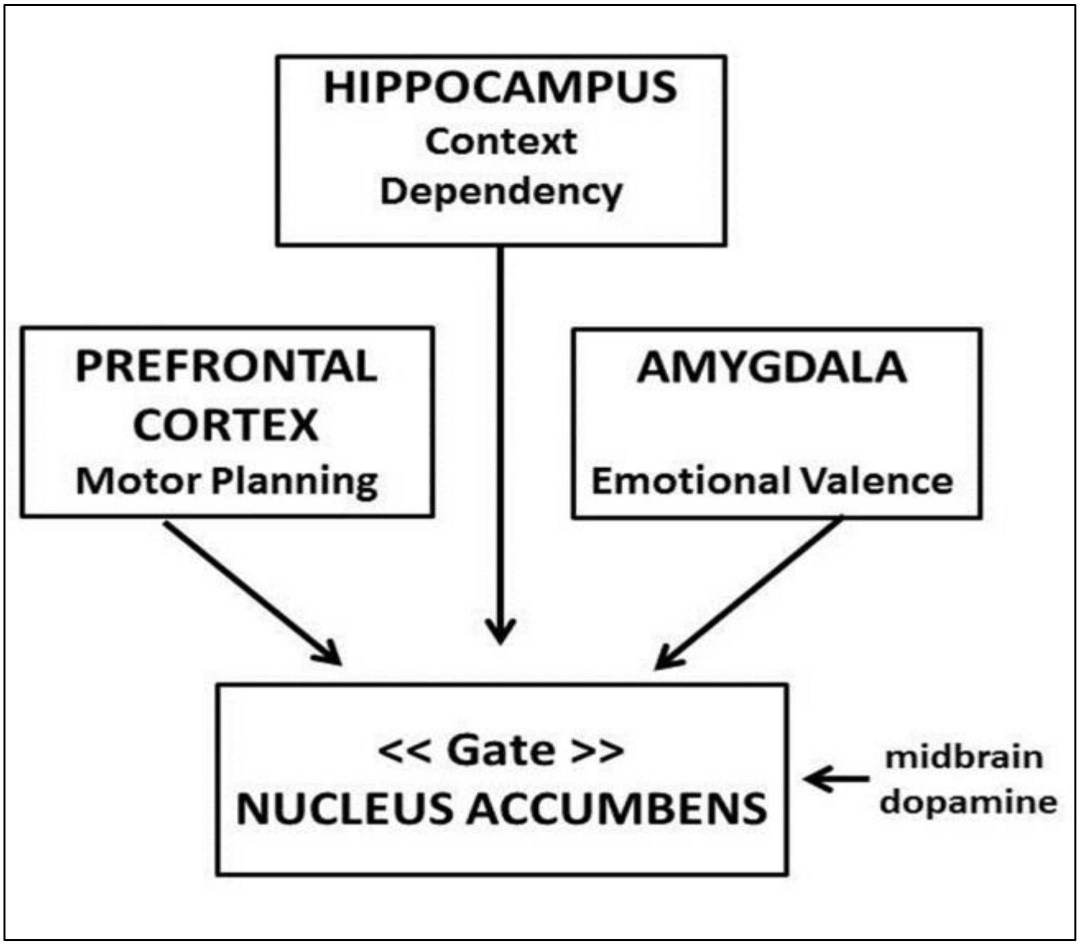


Figure 2. Three major influences on nucleus accumbens gating activity: the hippocampus (context), the prefrontal cortex (motor & planning), and the amygdala (emotional valence), Adapted from Newman and Grace (1999), with permission from Elsevier.

In both gating mechanisms we see hippocampal-influence associated with slow, task/context sensitive, “cold” cognition and amygdalar-influence associated with quick, emotionally sensitive, “hot” cognition, competing for selective gating attention priority (Levine, 2007). There is clear evidence of separate emotional and rational processing systems serving as important integration sites for affective and reflective stimuli. These different processing system profiles match long standing characteristic distinctions that have been made between system-1 and system-2 processing (Kahneman, 2003; 2011), as well as many other dual-processing theories. And while the idea and details of two separate, distinct rational and emotional dual-processing systems continue to be a subject of debate (Osman, 2004; Evans, 2012), evidence for two distinct, strongly connected systems continues to mount. The supportive research favoring clear emotional and rational processing pathways supports the use of Kahneman's dual-processing theory as a starting place for testing some of the assumptions of the current selective attention model, and should provide a means of exploring methods of up-and/or down-regulating each systems' functioning.

Optimization Tendencies: Satisficing and Maximizing

Of course what constitutes optimal behavior or the very best choice is often subjective and contextually dependent, itself. In some situations, there are both time and resources available to search for the very best solution to an important problem; for example, it would be foolish not to spend some time researching the best deal for your mortgage or car loan. However, most of the time, we face small problems requiring fast but really only adequate solutions. The ability to coordinate slow, reflective and quick, intuitive decision-making processes is of great importance to the successful handling of problems; especially in the case of quick, risky decisions.

Simon (1956) called the tendency for organisms to strive for adequate solutions rather than wasting time and resources searching for a (possibly) more optimal solution, "satisficing." Satisficing involves quick and automatic reliance upon intuition and heuristics; it is also thought to be especially vulnerable to bias (Schwartz, 2002). High satisficers tend to be “black and white” thinkers who are overly confident despite their often flawed decision-making strategy (Khun et al. 1994; Bruin et al., 2007). The problem is overconfidence keeps satisficers from experiencing self-doubt which otherwise leads people to reconsider or learn new strategies. In contrast, high maximizers are likely to push themselves to find an optimal solution even at a great cost in terms of time and energy investments. Maximizers have difficulty letting go of the search process itself, tending to be indecisive and perfectionistic, doubting their own conclusions, and often feeling regret about their selection regardless of the outcome (Khun et al. 1994; Schwartz, 2002; Bruin et al., 2007; Turner, et al., 2012). Maximizers seem to be much more troubled by the presentation of many choices than satisficers (Schwartz, 2002), which is especially problematic in a technological world that increases our choices almost daily. When you can search through thousands of choices online looking for a pair of shoes or a hat and still not be happy with your purchase because of your sensitivity to how many choices you had to turn down, it is clear there is a dark side to maximizing as well.

Indeed, the strength of optimization tendencies--satisficing and maximizing strategies--lies largely in their application within the proper context. Interestingly, descriptions of satisficers’ optimization tendencies align naturally with quick, intuitive, emotional, system-1, model-free processing, and amygdalar-influence theories, and are suggestive of habitual reinforcement for quick, confident decision-making. Likewise, maximizing tendencies clearly share many of the same characteristics of slower, rational, reflective, system-2, model-based processing models, and hippocampal-influence theories, suggestive of habitual reinforcement of sustained attention and search. Given their many shared characteristics, satisficing and maximizing tendencies might actually be behavioral manifestations of system-1 and system-2 processing dominance (both state and trait level); therefore, self-reported optimizing tendencies might prove to be a simple, convenient tool for revealing and predicting behavioral evidence of system-1 or system-2 processes habits.

Chapter 2

Research

Previous Research

The Iowa Gambling Task (IGT) is commonly used to study decision-making processes by simulating real-life decisions, testing long-term profitability strategies under conditions of uncertainty. It is specifically thought to invoke both emotional, system-1 processes, related to reward/punishment and rational, system-2 processes related to evaluation of long-term gains or losses (Overman et al., 2011). Previous research also suggests individual differences in deck preferences and patterns are specifically reflective of the involvement of both emotional and rational processes being activated during the IGT (Krain, et al., 2006; Overman et al., 2011). During the trials, participants are presented with four decks of cards labeled A, B, C, and D, from which they must choose.

Bechara et al. (1994, 1997) developed the Iowa Gambling Task expecting that all healthy participants would learn, over the course of the task trials, to optimize their end of game pay-off. Participants are expected to learn over trials which decks to avoid and how to maximize their ultimate payoff amount, and indeed they do, just at different rates and with differing deck preferences and risk strategies. Research has shown unexpected but consistent differences related to deck preferences, most prominently gender differences (Chiu & Lin, 2007; Overman & Pierce, 2013; Van Den Bos, Homberg, & de Visser, 2013).

While both genders go through a learning process over the course of trials, women tend to prefer cards from the deck that offers the highest single draw rewards and they are less sensitive to the occasional catastrophic losses that lead to low end of game payoffs (Chiu & Lin, 2007). Males, on the other hand, over the course of trials show a preference for decks with lower, consistent rewards but infrequent or small losses, leading to higher end of game payoffs--meaning males tend to outperform females on the IGT (Overman & Pierce, 2013). Previous research has examined other factors to explain these differences in performance but it appears to have to do with fundamental differences in focus or approach (Overman and Bachevalier, 2001; Overman & Pierce, 2013: Van den Bos et al., 2013). A loss-avoidant focus tends to lead participants to a preference for "good" decks C and D; whereas a reward-sensitive focus tends to lead to a preference for "bad" deck B (Chiu & Lin, 2007). Van den Bos et al. (2013) have suggested the behavioral and neurobiological gender differences are expressive of differences in the regulation of emotions; however, their sample size was so small their results are clearly not definitive.

Differing activation patterns in males and females during performance of the IGT have been found --medial orbital frontal cortex (mOFC) activation related to reward sensitivity in women and lateral orbital frontal cortex (lOFC) activation related to loss sensitivity in men (Overman, Boettcher, Watterson, & Walsh, 2011). Based on these differing patterns in men and women, Overman et al. (2011) reasoned that if activation of the mOFC was related to the selection of high-frequency, high-reward cards by women (associated with emotional processing) then experimental activation of this area in men should disrupt lOFC activity (associated with rational processing). They predicted this would result in men adopting a reinforcement strategy more similar to females. As expected, their effort to disrupt rational processing in males rendered male performance on the IGT similar to that of control condition females, but did not alter females' performance. They also attempted to stimulate rational processing activity in women, hoping it would cause women to adopt a reinforcement strategy more similar to men and improve their performance; however results using a moral dilemma essay prime were mixed (Overman et al., 2006; Overman et al., 2011).

The current research attempted to explore and expand upon this series of research findings. While none of this is meant to suggest men are more rational or that they make better decisions than women in general, or even on other cognitive tests, the fact that the IGT elicits both system-1 and system-2 processes and has shown consistent gender performance differences afforded several testable predictions.

Current Research

Identifying simple ways to up or down regulate emotional, system-1 and/or rational, system-2 processes at will would not only provide support for the proposed relationships and functions of the selective attention mechanisms detailed above and could also lead to a better understanding of how to control and/or protect system 1 and 2 tandem functioning. Levine (2007) has described a series of behavioral and neural research findings related to how humans switch between appropriate behavioral rules given environmental context changes, with special interest in brain structures related to selective attention mechanisms. The current behavioral research aimed to test some of the implications of the proposed relationships between these brain areas as they relate to selective attention and dual-processing. The main goals of this research were to examine the effects of disruption and dissonance stimulus on performance of the IGT and to examine possible relationships between IGT performance and self-report optimization tendencies.

Methods

Participants. One hundred and sixty-three college undergraduates (79 females and 63 males; ages 18-54) were recruited from the UTA SONA subject pool to participate for course credit. All participants provided informed consent. This research was approved by the University of Texas at Arlington Institutional Review Board.

Materials. This in-lab study consisted of an online survey and a simulated gambling task, with three experimental conditions. The survey was created using the online survey engine, Qualtrics©, and consisted of demographics questions regarding gender, age, ethnicity, GPA, and academic standing, as well as the 34-item Maximization Inventory (Turner et al., 2012) which assesses optimization tendencies and decision-making strategies, as shown in Appendix A.

The Iowa Gambling Task (Bechara et al., 1994) assesses risk preferences by simulating real-life decision-making using uncertainty, rewards, and penalties; it measures both positive adaptive and non-productive decisional behavior. In the game, players are presented with four decks of cards and given an endowment of $2000 at the beginning of the game. In this simulated gambling task, players must choose a deck and select one card at a time; every deck choice results in both a reward ($100 or $50) and a penalty (ranging from $0 to $1250). Decks A and B are considered “bad” decks due to their large trial-to-trial payoffs and occasionally catastrophic losses, all leading to an overall loss; however, while both decks have the same 10-trial payoff/loss ratios of $1000/$1250, the losses are distributed within the deck differently. In the B deck, a total of $1250 of loss is spread out over the trials; in the A deck, the loss occurs in a single trial. Decks C and D are considered “good” decks due to their lower trial-to-trial payoff amounts and low losses. These decks also share the same 10-trial payoff/loss ratios of $500/$250 and also differ only in the way their losses are distributed. Players must figure out which are the good and bad decks by trial and error and do not know how many trials will be presented.

My 200 trial Iowa Gambling Task version was designed using E-prime® software and utilized the same card deck and payoff/loss ratio structures as the original; however, it was customized to pause after every 10th trial for the experimental conditions. After every 10 trials, the task stopped and participants experienced either a pause (control), sniffed a bottle of essential oil (disruption), or viewed an optical illusion (dissonance), as shown in Figure 3. Task details, images, and instructions are shown in Appendix B.

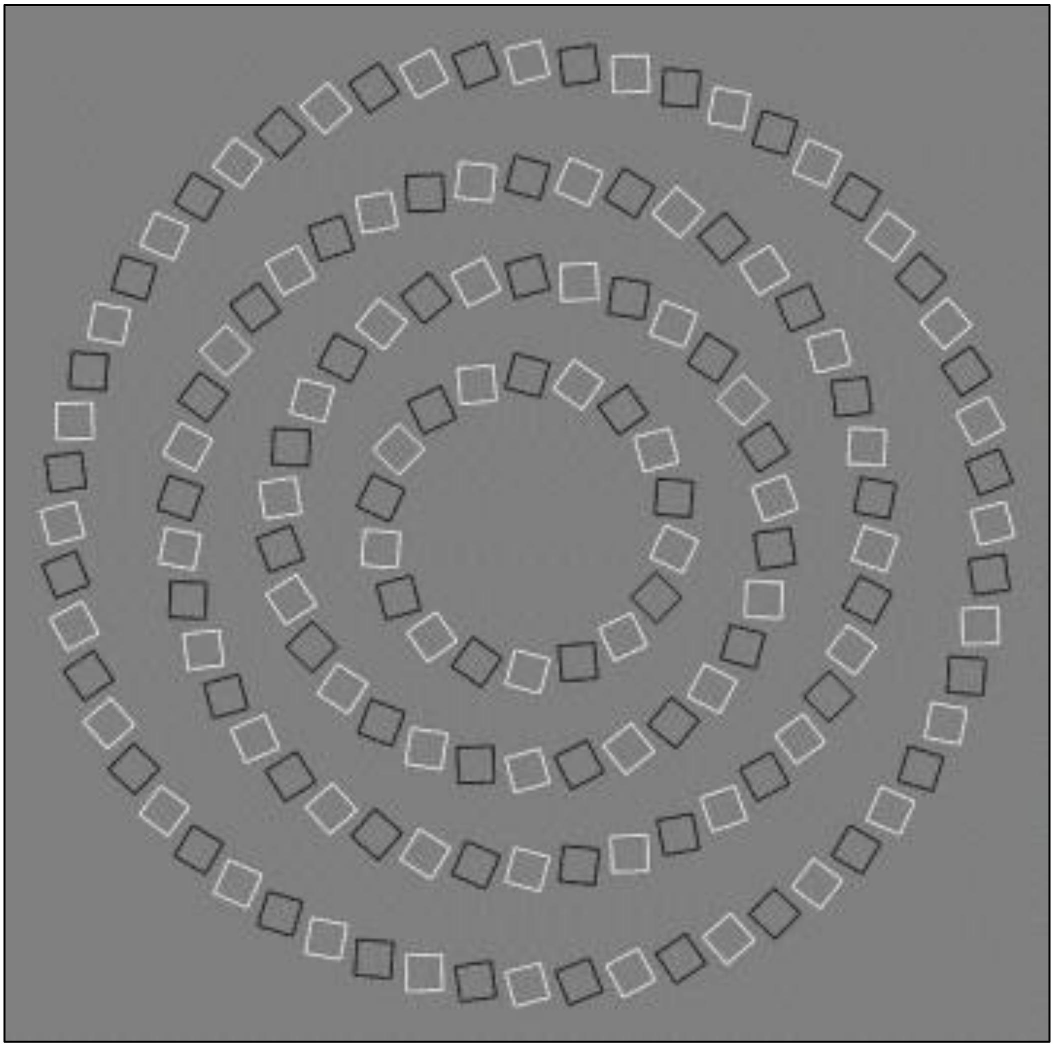


Figure 3. Pinna's Illusion. Retrieved November 1, 2014 https://commons.wikimedia.org/wiki/ File:Pinna%27s_illusory_intertwining_effect.gif. Image by Jochen Burghardt, distributed under aCC-BY-SA-3.0 license.

Modified Stimuli and Protocols. Consistent with Overman et al.'s (2011) use of essential oil as a cognitive disruption stimuli, my stimuli consisted of 20 different 15 ml glass vials filled with sterile sand and 2 ml of an essential oil; a list of the aromas used are listed in Appendix C. However, while they administered the aromas vials to each participant face-to-face--in order to facilitate procedural consistency across experimental conditions-- I had participants plug one nostril and sniff each vial themselves. Additionally, the researchers' efforts to activate system-2 processing using moral dilemma essay primes produced mixed results and could have elicited unintended emotional responses; therefore I used a novel stimulus. My logic was as follows; the inner conflict experience of dissonance triggers autonomic nervous activation and is known to improve performance on cognitive tasks, specifically the IGT (Drucaroff et al., 2011); therefore, a dissonance stimulus seemed well suited to the study's experimental goals. And although there is no extant literature specifically implicating optical illusions as a source for system-2 activation during cognitive tasks, they are known to create dissonance. They do this by taking advantage of the fact that central details in our visual field are processed more than peripheral details. Viewing an illusion creates an internal experience of conflict between sensory reality and perceptual experience – a mild, physiological dissonance.

Indeed, the use of an optical illusion to create dissonance and the expectation that it should activate system-2 processes is supported, at least theoretically, by research findings indicating that viewing an optical illusion creates a heightened state of focus, clarity, and problem-solving, while also lowering emotional reactivity (Adjamian et al., 2004). This is thought to be caused by the production of fast (gamma) oscillations in neural tissue caused when viewing an illusion (Gray & Viana Di Prisco, 1997; Adjamian et al., 2004; Niedermeyer & da Silva, 2004; Goddard, Sridharan, Huguenard, & Knudsen, 2012; Levine, Brown, & Shirey, 1999).

Procedures. Participants were greeted and shown to a computer on a desk in a small lab room. Informed consent was collected online at the first survey screen. Participants were asked to rate their responses to answer demographics questions and then rate their agreement with 34 optimization tendency items. Once the survey was completed, participants were randomly assigned to an experimental condition and then performed one of three versions (control, disruption, and dissonance) of the 200 trial IGT. At the end of every 10th trial in all three experimental conditions, the IGT included a 10 second pause. For the control condition, participants experienced a 10 second pause and then continued with the next set of trials. For the disruption condition, I used a modified version of the Overman et al. (2011) aroma disruption protocol; in their experiment researchers administered the aroma stimuli by hand and required participants to have one nostril taped up. To facilitate a consistent 10 second pause in all the experimental conditions, I had participants plug one nostril with their knuckle and sniff each vial of essential oils by themselves. Additionally, to ensure compliance, they were asked to rate their preference for each scent before continuing. For the illusion condition, participants were asked to focus on an optical illusion during the 10 second pause before returning to the trials.

After completing 200 trials, participants rated (on a 5 item Likert scale) how much they estimated the experimental condition (pause, oil, or illusion) affected their performance on the task, and read the debriefing statement. Lastly, researchers thanked each participant and answered any questions.

Chapter 3

Predictions and Results

Hypotheses

Previous research has shown consistent gender differences on performance of the IGT, wherein men tend to outperform women. First, in order to see if this sample would replicate these previous research findings, I predicted men would outperform women on the IGT in the control group, as measured by their final scores. Overman et al. (2011) showed that sniffing essential oils after every 10th trail during the IGT was an effective disruption manipulation that significantly decreased men's performance, such that men's performance was similar to women's general performance on the IGT. Therefore, I next predicted sniffing essential oils would lower men's performance in the disruption condition compared to males' performance in the control group.

Previous attempts to increase women's performance on the IGT using moral dilemma essays produced mixed results (Overman et al., 2011; Overman & Pierce, 2013). Given that a moral dilemma essay manipulation may have triggered unintended emotional responses in their study I used an optical illusion, with it in mind to elicit a purely physiological form of dissonance. I predicted viewing an optical illusion during performance on the IGT would improve women's but not men's performance, compared to their respective control groups. And lastly, to examine possible relationships between participants' self-reported optimizing tendencies and their performance on the IGT, I predicted that optimizing tendencies would be correlated with IGT performance, such that high self-reported maximizing would predict higher performance on the IGT. All of these predictions were based on the larger assumption that participants would take this research seriously and make a good-faith effort during their performance of the task.

Results

First, in order to test the prediction that men would outperform women on the IGT in the control condition an independent-samples t-test was conducted comparing gender and IGT performance in the control condition only. As expected, men (M= 630, SD=2755) had higher scores than women (M=418, SD=2818); however, these differences were not significant; $t(161)= 0.48$, $p=0.63$, $d=0.038$; therefore, my first hypothesis was not supported. My second and third predictions were that in the disruption condition, men's performance on the IGT would decrease but women's would not, while in the dissonance condition, women's performance would increase but men's would not when compared to each respective control group. To test these both of these predictions, a factorial ANOVA looking for an interaction effect between gender and disruption, as well as post-hoc analyses to see if the gender specific predictions are supported was performed, see Table 1.

Table 1. Gender and Condition as Predictors of IGT Scores

Factorial ANOVA for Gender and Condition Predicting Total Scores in the Iowa Gambling Task

Predictors	***F***	***df***	***p***	η^2
Gender	0.22	1	.64	.00
Condition	0.22	2	.81	.00
GenderXCondition	0.10	2	.91	.00
Error		156		

Note: Gender = male or female; Condition = control or not control; X = indicates an interaction effect.

Results indicated no significant main effects for gender (p=0.64); η^2=0.00) or condition (p=0.81); η^2=0.00) and no interaction effects between gender and condition (p=0.91); η^2=0.00) in this sample; therefore my second and third hypotheses were also unsupported. Lastly, to test my prediction that maximizing tendencies would be positively correlated with performance on the IGT a simple regression was conducted, examining the three Maximization Inventory sub-factors (satisficing, decision difficulty, and alternative search), for results see Table 2.

Table 2. Optimization Tendencies as Predictors for IGT Scores

Simple Linear Regressions of Satisficing and Maximizing Measures Predicting Total Scores on the Iowa Gambling Task

Predictors	***b***	***SE***	**β**	***t***	***p***
Satisficing	27.14	58.37	0.04	0.47	.64
Maximizing-Decision Difficulty	9.00	29.68	0.02	0.30	.76
Maximizing-Alternative Search	-23.35	29.67	0.06	-0.79	.43

Results indicated no significant relationships between performance on the IGT and satisficing, decision difficulty, or alternative search in this sample, so my last prediction was also unsupported. Additional analyses looking for learning effects over the IGT trials were also conducted. Blocks of 50 trials were created, representing 4 different time measures across the trials to compare to percentage of deck choices (A, B, C, and/or D) by participants. A multivariate ANOVA for time block, gender, and experimental condition as possible predictors of good decks (C & D) was also conducted, as another measure of IGT performance (see Table 3).

Table 3. Predictors of Number of Good Cards Selected

Multivariate ANOVA for Time Block, Gender, and Condition Predicting the number of "Good" Cards Selected					
Predictors	**Wilk's λ**	***F***	***df***	***p***	**η^2**
Time	.94	3.55	3	.02	.07
TimeXGender	.98	0.91	3	.44	.02
TimeXCondition	.97	1.88	3	.14	.04
TimeXGenderXCondition	.96	2.21	3	.09	.04
Gender		0.40	1	.53	.00
Condition		0.06	1	.80	.00
GenderXCondition		0.20	1	.66	.00

Note: Gender and condition are between subject factors, and Time is a within subjects factor. Wilk's λ = Wilk's Lambda; η^2 = partial eta-squared; Time = Time block (either trials 1-50, 51-100, 101-150, or 151-200); Gender = male or female; Condition = either control or not control; X = indicates an interaction effect.

Results did indicate a significant main effect for learning across the 200 IGT trials, with a small effect size (p=0.02; η^2=0.07) and an interaction effect for time, gender, and condition that approached significance (p=0.09); η^2=0.04). However, no main effects for gender or condition and no interaction effects for time and gender, time and condition, or gender and condition were found in this sample. Another identical multivariate ANOVA was performed for bad decks (A & B) and the results patterns were identical (see Table 4).

Table 4 Predictors of Number of Bad Cards Selected

Multivariate ANOVA for Time Block, Gender, and Condition Predicting the number of "Bad" Cards Selected

Predictors	**Wilk's λ**	***F***	***df***	***p***	**η^2**
Time	.94	3.55	3	.02	.07
TimeXGender	.98	0.91	3	.44	.02
TimeXCondition	.97	1.88	3	.14	.04
TimeXGenderXCondition	.96	2.21	3	.09	.04
Gender		0.40	1	.53	.00
Condition		0.06	1	.80	.00
GenderXCondition		0.20	1	.66	.00

Note: Gender and condition are between subject factors, and Time is a within subjects factor. Wilk's λ = Wilk's Lambda; η^2 = partial eta-squared; Time = Time block (either trials 1-50, 51-100, 101-150, or 151-200); Gender = male or female; Condition = either control or not control; X = indicates an interaction effect.

As a manipulation check, we asked participants how much they felt the experimental stimuli (pause, sniffing oils, or viewing an illusion) had affected their performance on the IGT by rating their level of agreement on a 5 point Likert scale (1 indicating “strongly disagree” and 5 indicating “strongly agree”). A Pearson’s r correlation comparison of total scores and perceived effect on performance revealed a negative correlation, $r=-0.212$, $n=162$, $p=0.007$. Overall, better performance on the IGT was significantly correlated with less perceived experimental condition effect.

Chapter 4

Discussion

These results suggest that males' and females' performance in the current sample did not differ significantly, as had been a consistent finding in previous research. The current research was not able to replicate previous findings indicating gender differences on performance of the IGT, wherein men's final scores have been shown to generally be significantly higher than women's scores due to differing task focuses and risk-taking strategies. Comparing gender and IGT performance in the control condition, men on average did score higher than women in this sample but these results were not significant. This comparison was meant to check for normality in the sample and as a normative result for comparison with the experimental conditions. This expectation was not met, however other factors than sample normality could have been involved.

Additionally, these results were not consistent with previous research indicating that sniffing essential oils during the IGT lowered men's but not women's performance, when compared to the scores of their respective control groups. I predicted this sample would reflect similar gender differences in both stimulus response and overall scores; however the current study was not able to replicate these findings either. In a departure from previous attempts to increase women's performance on the IGT, I used an optical illusion for the second experimental manipulation, hoping to create a clean, physiological experience of dissonance for participants and predicted dissonance would improve women's but not men's performance, in comparison to the control group; however, the current results did not support the expected gender difference patterns in either condition.

And lastly, my prediction that optimizing tendencies would be correlated with IGT performance also went unsupported. Results indicated no significant relationships between performance on the IGT and any of the Maximization Inventory (Turner et al., 2012) subscales--satisficing, decision difficulty, and alternative search--in our sample. Instinctively, one might expect maximizing, due to the time and effort involved, would lead naturally to better decisions; however, Jain, Bearden, & Filipowicz, (2013) and Furl (2010) have shown that this is not always the case. We predicted that maximizers would perform better than satisficers but would have been just as interested in an opposite result. This sample showed different score patterns and deck preferences than were expected for gender in all conditions; that is not to say that these participants all performed poorly on the IGT. The expected gender, condition, or learning differences over the task trials that have been found previously simply weren't found in the current sample.

Previous IGT research has found normative gender differences in performance (men performing better overall), deck preferences (women preferring "bad" deck B and men preferring "good" deck D), and learning over the trials (these gender differences increasing over more trials) (Overman et al. 2006; Chiu & Lin, 2007; Miua, Heilmana, & Houserb, 2008; Overman et al. 2011; Overman & Pierce 2013) in sample sizes ranging from approximately 25-30 participants in each group. One of Overman's sample sizes was larger, with approximately 70 for each group (Overman et al. 2011). However, post hoc power analyses on the current sample indicated effect sizes so small that to find a significant effect we would have needed a sample size of 1600. In light of this information, the fact that we did not find the expected group differences may be more indicative of a unique sample rather than an inadequate sample size or, of course, it could simply be an indicator of no effect.

Limitations and Future Research

The first limitation that stands out for the current research is that the experiment was conducted during the last 2 weeks of a spring semester. The last minute timing of this study was not intentional, as unpredictable software licensing issues pushed the experiment back in the term. This forced us to collect a sample consisting of participants who had put off completing their psychology research requirements until the very end of the term. A procrastinator sample may consist of individuals sharing so many habits and personality attributes that it might provide a very limited range of student characteristics, which may explain why this sample demonstrated such unexpected behaviors and results. However, while it might be easy to blame these results on procrastination, previous research looking for correlations between aberrant performance of the IGT and conscientiousness (presumably a functional opposite of procrastination) found no significant relationship (Skeel et al., 2006). This may be suggestive of emotional and/or environmental factors playing a more important role than individual differences or the problems associated with a self-selected sample.

Indeed, many participants mentioned having high levels of stress and anxiety about balancing their finals, papers, and especially about finishing up their research requirement credits with so few research options available so late in the term; and although this is anecdotal, there is no question that the last few weeks of a college semester are stressful. These participants' cognitive resources were likely taxed by stress; this could have easily altered their focus and risk strategy during the task, as well as their responsiveness to the experimental stimuli. These students may have shown up to the study so emotionally, system-1 activated already that an optical illusion, dissonance stimulus was simply too subtle to elicit rational, system-2 activation from these students. Indeed, previous research has shown a significant deleterious effect of stress and anxiety on performance of the IGT (Miua, Heilmana, & Houserb, 2008). Unfortunately, this was not considered prior to the study, which might have allowed us to add in anxiety and/or stress measures to account for the amount of anxiety participants were experiencing at the time. Future research would likely benefit from the addition of measuring anxiety at the time of the study.

One environmental issue that may also have contributed to these unexpected results was the ambient temperature in the lab, which was around 62 degrees Fahrenheit. It was cold enough for us to provide blankets for participants and lab members who were uncomfortably cold and to keep the main lab door open when possible to allow air exchange from the hallway. Prior research on the effects of ambient temperature on the performance of cognitive tests found that heat is more likely to decrease performance than the cold (Cheema & Patrick, 2012; Tong, et al., 2012); however, it should be noted that they measured performance at a low of only 67 degrees Fahrenheit. With the lab 5 degrees colder than their experimental condition, the intense chill still might have had a negative effect on participants' performance and responsiveness to experimental stimuli.

Another possible source of error could have been problems with the research design itself, as my experimental protocols may not have matched previous research protocols in any number of ways. For example, my version of the IGT was produced in-house and efforts to replicate the original version of the IGT may not have been entirely successful. Every effort was made to replicate the original perfectly and to make only necessary changes to accommodate the addition of experimental manipulations; however, small, but important differences can occur in the process of reading and interpreting other researchers' methods sections. However, Overman et al. (2012) used pauses for their experimental condition and there was no mention of problems in their results. Furthermore, there are so many different versions of the IGT (with different numbers of trials and different numbers of decks presented) included in extant literature, it suggested the gender difference effects tested in the current research are quite robust.

Additionally, we used a modified version of the Overman et al. (2011) experimental protocol in which they administering the essential oil vials one by one, in person. Having participants open and sniff each vial of essential oil independently required participants to keep track of and following a short set of procedures (opening a numbered vial, holding one nostril closed, sniffing for three seconds, closing the vial, replacing it in the proper spot) which could have increased their cognitive load during the task as well, thereby undermining their focus and performance (Van Merrienboerand & Sweller, 2005). However, one would expect a confounding effect specific to a single condition would make performance in that condition stand out and in this sample neither gender nor condition appeared to affect performance. Any and all of these factors could have had unexpected effects on performance, as well as responsiveness to the manipulation stimulus. While there are many possible explanations for the surprising results, future research should administer this research in its current form earlier in the semester, or perhaps across an entire term, in an environment with a more neutral ambient temperature, before dismissing these protocols outright.

After accounting for the aforementioned limitations, it is also quite possible that in addition to sample, stress, and environmental constraints, that the manipulations (e.g. aroma and illusion) –though theoretically valid-- might have affected participants in a variety of ways that introduced noise into my findings. A cleaner, more focused approach without the possible confounds associated with aromas and optical illusions, but that is still able to influence system-1 and system-2 processing would be beneficial. Two examples of technology that could aid us in the ongoing quest to understand how system-1 and system-2 processing can be experimentally manipulated and controlled are transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS). Both of these technologies are able to noninvasively up and down regulate neural activity in areas on the surface of the cortex (e.g. DLPFC and OFC). The next phase of this research will endeavor to improve upon the experimental techniques and incorporate the exciting possibilities technologies of this sort would provide.

Conclusions

The current behavioral research aimed to test some of the implications of the proposed relationships between several brain areas as they relate to selective attention by examining behavioral evidence of dual-processing. Levine (2007) has suggested that strong factors such as chronic stress, as well as subtle, acute factors like relaxation and/or time pressures, likely shift the balance of system-1 and system-2 influences over attention at any given moment. Under stress or panic, humans have a tendency to revert to quick, emotional or intuitive decisions; however truly optimal decision-making requires activation of both system-1, emotional and system-2, rational processing, as these systems are meant to work together. Given the end of semester timing of this study and the unexpected results, it is possible these results serve as a strangely apt, real life testimony to how easily rational, system-2 processing can be disrupted.

Beyond the ample supportive evidence for strong neural bundles related to clear and distinct emotional and rational processes, as have long been suspected and argued by many, one of the most exciting aspects of recent selective attention research is evidence of weaker, overlapping circuits between these two systems and seemingly between all of the brain areas related to attention. It is this overlap and interaction that may ultimately be the more interesting story, suggesting mechanisms for integration of complex mixtures of both emotional and rational, fast and slow processing, which better account for the messy, often complex, and contradictory nature of human behavior. While we still clearly have much to learn about how separate, distinct emotional and rational pathways work themselves, long-term efforts to improve quick decisions, especially under conditions of uncertainty, will likely require a much better understanding of these crossover interactions as well and may provide means to exploit their potential for improving other complex and nuanced emotional-rational decision processes as well. The current research, while suffering from a number of potential confounds, provided a number of important lessons that can be used to inform future research efforts to improve quick decisions.

Appendix A

Maximization Inventory Items

Satisficing Subscale

1. I usually try to find a couple of good options and then choose between them.
2. At some point you need to make a decision about things.
3. In life I try to make the most of whatever path I take.
4. There are usually several good options in a decision situation.
5. I try to gain plenty of information before I make a decision, but then I go ahead and make it.
6. Good things can happen even when things don't go right at first.
7. I can't possibly know everything before making a decision.
8. All decisions have pros and cons.
9. I know that if I make a mistake in a decision that I can go "back to the drawing board."
10. I accept that life often has uncertainty.

Decision Difficulty Subscale

11. I usually have a hard time making even simple decisions.
12. I am usually worried about making a wrong decision.
13. I often wonder why decisions can't be more easy.
14. I often put off making a difficult decision until a deadline.
15. I often experience buyer's remorse.
16. I often think about changing my mind after I have already made my decision.
17. The hardest part of making a decision is knowing I will have to leave the item I didn't choose behind.
18. I often change my mind several times before making a decision.
19. It's hard for me to choose between two good alternatives.
20. Sometimes I procrastinate in deciding even if I have a good idea of what decision I will make.
21. I find myself often faced with difficult decisions.
22. I do not agonize over decisions.

Alternative Search Items

23. I can't come to a decision unless I have carefully considered all of my options.
24. I take time to read the whole menu when dining out.
25. I will continue shopping for an item until it reaches all of my criteria.
26. I usually continue to search for an item until it reaches my expectations.
27. When shopping, I plan on spending a lot of time looking for something.
28. When shopping, if I can't find exactly what I'm looking for, I will continue to search for it.
29. I find myself going to many different stores before finding the thing I want.
30. When shopping for something, I don't mind spending several hours looking for it.
31. I take the time to consider all alternatives before making a decision.
32. When I see something that I want, I always try to find the best deal before purchasing.
33. If a store doesn't have exactly what I'm shopping for, then I will go somewhere else.
34. I just won't make a decision until I am comfortable with the process.

Appendix B

Game Details

Task Instructions

Participant Number

Screen 1:

DISSONANCE, DISRUPTION, AND DECISIONS
PRESS ANY KEY TO BEGIN

Screen 2:

INSTRUCTIONS

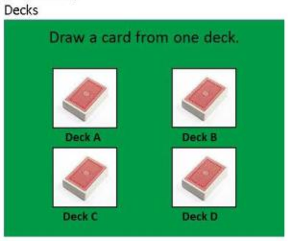
At the beginning of each trial, you will see four decks of cards. Choose a card from one of the decks by pressing its corresponding key.
Each deck has a unique set of rewards and penalties associated with it. As with real card decks, your choice of one deck will in no way affect the rewards and penalties of the other decks.
PRESS ANY KEY TO CONTINUE

Screen 3:

You will start the game with $2000; the goal is to win as much as possible. You can get more points by choosing the right deck(s). After each choice, you will receive feedback regarding your wins and losses.
This will be shown as three values on the screen:
Your Last Choice =
Win: Lose:
$100 $0
Running Total: $1250
After every 10th trial there will be a pause; please follow the directions on the screen.
PRESS ANY KEY TO CONTINUE

Game Trials

Decks



Feedback Screen

Your Last Choice =

Win: **Lose:**
$100 **$0**

Running Total: $1250

Experimental Conditions:

Participants will be randomly assigned to one of three experimental conditions – control, disruption, and dissonance conditions. They will play identical games but each condition will involve different experimental instructions at the end of every 10^{th} trial.

- **Control Group Instructions:**
  "PROCESSING... AFTER A BRIEF PAUSE THE GAME WILL CONTINUE AUTOMATICALLY"
- **Disruption Group Instructions:**
  "PLEASE OPEN ONE BOTTLE AND (with your eyes closed) TAKE ONE DEEP BREATH. THEN RATE YOUR PREFERENCE FOR THE SCENT ON THE FORM. PRESS ANY KEY TO CONTINUE"
- **Dissonance Group Instructions:**
  "PLEASE CONCENTRATE ON THE FOLLOWING IMAGE FOR AS LONG AS IT IS DISPLAYED
  (Try to hold your focus the entire time.) THE GAME WILL CONTINUE AUTOMATICALLY
  PRESS ANY KEY TO CONTINUE"

Manipulation Check Screen:

Thank you! Finally, please rate your agreement level with the following statement.
The [condition] after every 10th trial affected my performance on the simulated gambling task.
1 -> Strongly Agree, 2 -> Agree, 3 -> Neither Agree Nor Disagree, 4 -> Disagree, 5 -> Disagree Strongly

Debriefing Screen:

Debriefing Statement:

This research is examining the effects of cognitive dissonance and disruption on decisions made during a simulated gambling task. You filled out a series of questionnaires regarding your decision-making characteristics and strategies, and you performed a task that measured your choice behavior and learning over many game trials.

We are interested in any relationships that might be found between the self-report survey measures and performance on the task. Additionally, we are interested to see if dissonance might be used in certain circumstances to improve decision-making performance.

PRESS ANY KEY TO CONTINUE

Goodbye Screen:

"THANK YOU FOR YOUR PARTICIPATION! Your SONA credit will be issued shortly."

APPENDIX C

List of Essential Oils

1. Blue tansey
2. Frankinsense
3. Black spruce
4. Vetiver
5. Palmarosa
6. Ginger
7. Clary sage
8. Patchauli
9. Geranium
10. White thyme
11. Basil
12. Orange
13. Lemongrass
14. Lemon
15. Scotch pine
16. Rose
17. Tea tree
18. Sandlewood
19. Pink grapefruit
20. Rosemary

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Biographical Information

Wyn E. Taylor completed an associate degree at Tarrant County College and later earned her B.S in psychology at Texas Wesleyan University; where she found a new sense of clarity and purpose working as a research assistant in labs with several research mentors. The summer before being accepted into the University of Texas at Arlington experimental psychology B. S. to Ph.D. program, Wyn volunteered in a memory and learning lab for an fMRI study, recruiting, screening, and running participants; this continued once entering the graduate program. Next she worked at the Center for Healthy Living and Longevity, a research and exercise intervention--focused on fall prevention for older adults--in the UTA kinesiology department, performing physiological and psychological testing, as well as supervising other graduate and undergraduate research assistants.

Ultimately, Dr. Daniel Levine's decision-making lab became her research home, where she built an active, sought after lab and served as the lab manager for several years. Given Wyn's ongoing interdisciplinary collaborative research work, she has developed skills and knowledge in many areas of psychological, physiological, and psychometric research. Her central research interests are currently related to the effects of emotion on quick and/or risky decisions, selective attention mechanisms, dual-processing theories, and optimization tendencies. Beyond feeding her wide range of research interests, her many responsibilities as a graduate researcher assistant and her many collaborative projects she has also developed an affinity for teaching and mentoring students.

After earning her master's degree in experimental psychology at UTA, her future plans are to complete her doctorate requirements and then pursue an academic career as a professor of psychology, teaching classes and performing behavioral research either in the U.S. or possibly abroad.