

**Circadian Synchrony Impacts on Individuals' Judgements, Risk Taking and Belief  
Perseverance**

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*Author Note*

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### **Abstract**

Existing research suggests that availability of cognitive resources has a potentially significant impact on information processing capabilities. Circadian variations constitute one of the factors that are likely to impact on an individual's availability of cognitive resources. Accordingly, this thesis sought to investigate the impact of circadian variations on information processing from the perspective of belief perseverance and framing effects. It comprises of three experiments that were conducted using a sample of students from Kingston University as the participants. Experiment 1 examined the influence of circadian variations on belief perseverance and the moderating impact of socially distributed thinking. The results reveal that participants tested at their circadian congruent times had significantly less belief perseverance compared to counterparts tested at their circadian incongruent times. Socially distributed thinking was also found to contribute towards a reduction in belief perseverance. Experiment 2 examined the influence of circadian variations on belief perseverance and type of reason given (supporting or disconfirming the belief) in a legal context. From the results, participants tested at their circadian congruent times reported higher mental alertness and greater task involvement compared to participants tested at their circadian incongruent times, but at a non-significant level. In addition, there was no interaction effect between time of testing and the type reason given on belief perseverance and confidence scores. Experiment 3 tested the effects of circadian variations on framing effects in the context of the Classic Asian Disease Problem, Lung Cancer and HIV Virus. Significant framing effects were found for participants tested at their circadian incongruent times. No significant interaction was found between framing and order of the frame. The thesis discussed the implications of the findings and offered recommendations.

**Keywords:** Circadian Variations; Belief Perseverance; Cognitive Resources; Socially Distributed Cognition; Framing Effects.

## **Chapter 1: Introduction**

### **1.1 Study Background**

People undergo daily variations in their arousal levels that can affect cognitive functioning (Schmidt, Collette, Cajochen, & Peigneux, 2007). Some may reach their functional peak during the morning (morning people) and some in the evening (evening people). Research on circadian variations has established that synchrony between circadian type and time of testing matters for cognitive tasks requiring executive control and deliberative processes, but not so much for tasks that required intuitive and automatic processes (Yoon, May, & Hasher, 1999). Meanwhile, dual-process approaches to the study of judgement and decision-making has shown that people may produce judgements and make decisions using either deliberative, effortful processes or intuitive and associative processes (Kahneman, 2012). The research reported here explored whether or not people tested at their optimal time of the day will be more likely to rely on deliberative processes in judgement and decision-making tasks, compared to people tested at their non-optimal time of the day. Specifically, the work reported here examined the extent to which people's tendency to demonstrate belief perseverance, framing effects and cognitive reflection would be influenced by circadian preference and time of testing. The research had three objectives:

- (1) To determine how circadian synchrony impacts individuals' judgements.
- (2) To determine how circadian synchrony impacts individuals' risk-taking.
- (3) To determine how circadian synchrony impacts individuals' ability to suppress intuitive but erroneous answers in favour of a more reflective answer.

### **1.2 Circadian Variations**

Individuals tend to experience patterns of arousal and dormancy that vary during the day on a relatively regular cycle. Such patterns are commonly referred to as circadian variations

or rhythms (Hornik & Tal, 2010; Dickinson & McElroy, 2012). They have also been described as the cycles that regulate a range of physiological processes, such as when to sleep or eat. These rhythms also determine when one's peak and off-peak hours of performance are experienced during the day (Bechtel & Abrahamsen, 2010; Kyriacou & Hastings, 2010). The variations have been demonstrated in cardiorespiratory responses (e.g. heart rate and blood pressure), hormonal secretion (e.g. catecholamines and cortisol), metabolic variables (e.g. oxygen consumption and carbon dioxide output) and thermoregulatory variables (e.g. body temperature and blood flow) (Giacomoni, Edwards, & Bambaiechi, 2005).

The wake-sleep regulation model suggests that the human circadian system involves two basic endogenous mechanisms: a self-sustaining endogenous circadian pacemaker (ECP), and a sleep-wake cycle (SWC). Each mechanism regulates specific functions, for example, ECP regulates body temperature, and rapid eye movement (REM) regulates sleep while SWC regulates sleep timing and slow-wave sleep propensity (Natale & Cicogna, 1996; Saper, Cano, & Scammell, 2005). Similarly, Buhr, Yoo, and Takahashi (2010) examined that circadian is driven by variations in body temperature; in which case, temperatures reach their peak levels at a certain point during the time of an individual's optimal performance.

In terms of impact, circadian variations have been suggested to be one of the underlying causes of differences in individual performance for tasks that require working memory capacity, subjective alertness, visual attention and reaction times (Wright, Hull, & Czeisler, 2002). Arousal levels are therefore likely to fluctuate in a regular pattern (Valdez, Ramírez, & García, 2012). Besides tasks that require working memory, circadian variations also have an influence on performance in other contexts, such as motor skills. Athletic performance has, for example, been found to be highest in the afternoon/early evening when most people have their core body temperature and metabolism at near peak values. In this case, circadian



variations have a significant influence on muscle strength and efficiency in terms of maximal voluntary contraction (Callard, Davenne, Gauthier, Lagarde, & Van Hoecke, 2000).

Research in the field of circadian variations further indicates that individuals do not generally share the same circadian patterns. Some are likely to reach their peak arousal levels during the morning hours, while others are more likely to be more alert during the evening hours. Such differences have led to the categorisation of individuals as either “early birds” (morning types) or “night owls” (evening types) (Stevens et al., 2011). In general, morning type people tend to perform better when they are subjected to tests in the morning rather than evenings. The pattern is reversed for evening type people, where better performance results are recorded in the evening (Ezzatian, Pichora-Fuller, & Schneider, 2010). Hence, this suggests that individual differences in circadian variations could be a contributing factor towards an individuals’ ability to perform a specific task.

Physiological data provides reliable support for the morning and evening type persons arising from circadian variations. Natale and Alzani (2001) found that evening type persons on average reach the acrophase/peak of body temperature during the second half of the day. By contrast, morning type persons reach their peak level one to three hours earlier than the evening types. Similarly, Bailey and Heitkemper (2001) examined 19 subjects while Kudielka, Federenko, Hellhammer, and Wust (2006) analysed 112 subjects and found that in morning type persons the acrophase of melatonin occurred earlier than in the evening type persons. Acrophase, in this context, means the estimated peak time when melatonin, a hormone that is produced by animals and human beings, is responsible for the regulation of sleep and wakefulness (Natale & Alzani, 2001).

Availability of cognitive resources during various times of the day has further been associated with the presence of circadian variations among individuals. More specifically, an individual at his or her optimal time of the day is likely to have more cognitive resources

available to undertake certain tasks (Dickinson & McElroy, 2012). During their non-optimal time, the individual will experience a shortage of cognitive resources, which, in turn, results in inferior performance. This is especially the case for tasks that require higher levels of cognitive efficiency (Natale, Alzani, & Cicogna, 2003; Schmidt et al., 2007). As an example, Bodenhausen (1990) and Bodenhausen, Macrae, and Sherman (1999) found that individuals are likely to depict social stereotyping during their non-optimal times. This observation was attributed to the lack of adequate cognitive resources that are required to correct the judgemental heuristic.

In relation to real-life contexts, research has also shown that sleep-related car accidents are usually at their highest between 2am and 4am, when the majority of individuals have depleted cognitive resources after spending the earlier part of the day working (Lucidi, Mallia, Violani, Giustiniani, & Persia, 2013; Crummy, Cameron, Swann, Kossmann, & Naughton, 2008). Such incidents are linked to the view that, at circadian incongruent times, an individual's visual attention, reaction times and recall memory are negatively affected (Wright et al., 2002; Horowitz, Cade, Wolfe, & Czeisler, 2003). In some extreme cases, performance dips in shift workers have been blamed for some of the major disasters in recent history such as the Exxon Valdez oil spill and the Chernobyl nuclear explosion (Coren, 1996).

### **1.3 Influence of Circadian Variations on Cognitive Processes**

A substantial amount of research has been conducted in relation to the nature of the relationship between circadian variations and cognitive processes, which form the basis of the present experiment. The variations are considered to be responsible for differences in performance of tasks that require working memory capability and relatively high levels of alertness and attention (Wright et al., 2002). In addition, the circadian variations may play a crucial role in differences associated with cognitive processes such as memory, learning,

focused attention, reaction time, time estimations and arithmetic calculations (Tranah et al., 2011; Valdez et al., 2012). In this context, individuals working at their circadian congruent times are characterised by relatively high availability of cognitive resources that are required in the performance of tasks. When required to work at their circadian incongruent times, the same individuals are likely to be characterised by inferior performance due to unavailability of adequate resources required to perform tasks that demand greater cognitive efficiency (Schmidt et al., 2007).

The potential impact that circadian preferences have on cognition has also been demonstrated through research, theoretically linking working memory and decision-making. Sleep deprivation is, in this context, associated with fewer cognitive resources available for an individual to engage in information processing (Mullington et al., 2003). According to Kerkhof and Van Dongen (2010), decision-making constitutes as one of the domains of executive functions that require the use of a number of cognitive operations. Research on changes in brain neural activity after sleep deprivation has found the presence of a significant decrease in cortical activations, a critical component of decision-making. As a result of the decreased neural activity, individuals find it difficult to sustain their cognitive flexibility (Mu et al., 2005).

However, a few studies have suggested that sleep deprivation may not always affect decision-making. In some cases, individuals can adapt to sleep deprivation through adaptive cerebral response (Drummond, Gillin, & Brown, 2001). Harrison and Horne (2000) also argue that the impact of sleep deprivation on cognitive capacities is not global in the sense that some cognitive functions are unaffected. The study suggests that numerous decision-making domains, which do not require complex integrating of tasks such as flexibility and innovation, are unaffected by sleep deprivation. Linking to circadian preferences, such

findings suggest that the influence of circadian congruence or incongruence on the performance of tasks may be dependent on the nature of task at hand.

In some cases, the results of the relationship between circadian variations and performance of tasks requiring cognitive performance may vary based on the method of measurement used. The three common measures include: time of the day protocol, constant routine protocol and forced desynchronisation protocol (Valdez et al., 2012). In brief, a time of the day protocol entails measuring the performance several times in the course of the day. Contradictory results have been found in time of the day protocol and attributed to the lack of control of factors such as physical activity, temperature and light, which are likely to modify the circadian variations (Scheer et al., 2010). A constant routine protocol involves minimisation of exogenous influences by keeping ambient light and temperature constant. It overcomes the problems associated with time of the day protocol by keeping constant all conditions that are likely to influence circadian rhythms (Valdez et al., 2012).

Forced desynchronisation requires that participants adhere to their sleep-wake cycle (Dijk, Duffy, & Czeisler, 1992). The performance of the individual is then assessed during circadian congruent and incongruent times. Studies making use of forced desynchronisation have shown that performance tends to correlate with circadian rhythms, in which case, best performance occurs when participants are assessed at their circadian congruent times. Poor performance, on the other hand, occurs when participants are assessed during their circadian incongruent times (Buxton et al., 2012). In the study 1 experiment, the forced desynchronisation method is preferred, since it is difficult to control factors such as temperature, food intake and physical activity in a normal setting. In this study, the impact of circadian variations is investigated in relation to belief perseverance and framing effects.

#### **1.4 Belief Perseverance**

Belief perseverance describes the tendency among individuals to display biased responses to information as a way of maintaining an existing belief or conception (Jelalian & Miller, 1984). Such belief persistence has been demonstrated in a number of real-life situations. For example, IBM employees who had ownership of the company's stock during the early 1990s were characterised by support of information depicting rosy performance about the company's performance. At the same time, they discounted evidence showing that IBM was facing increasing competition from Microsoft. A few years later, IBM stock fell significantly, leading to the loss of large sums of money. In such a case, perseverance of the belief that the company was performing well, despite evidence to the contrary, led to loss (Pompian, 2012). A rational investor would have been expected to change the investment position based on the new information released to the market (Ward, 2004). Therefore, belief perseverance hinders the process of adjusting existing views.

Ross, Lepper, and Hubbard (1975) conducted one of the most notable experiments on belief perseverance. In the experiment, the subjects were asked to make distinctions between genuine and inauthentic suicide notes. After completion of the tasks, the subjects were provided with feedback indicating their success levels. Some were told they had failed, others performed moderately well, and others were excellent. They were then thoroughly debriefed by being informed that the feedback was completely random and predetermined. In other words, the feedback was not based on the actual assessment of the authenticity of suicide notes. In a final questionnaire, the subjects were requested to estimate the actual number of correct responses they had made in the earlier questionnaire as well as indicate their probable success for similar tasks in the future (Ross et al., 1975).

Interestingly, a significant majority of the subjects, despite being debriefed about the random nature of the initial feedback, displayed a marked influence of the prior information

in making the subsequent judgements. As an example, subjects who had been informed that they had mainly made incorrect judgements still held the belief that their future problem-solving capabilities were poor. Later studies by Ross and his colleagues also found the presence of belief perseverance even after the subjects were debriefed, and informed that the initial outcomes had been staged (Lepper, Ross, & Lau, 1986; Jennings, Lepper, & Ross, 1981).

The exact mechanisms that are responsible for belief perseverance are yet to be fully established. However, Nisbett and Ross (1980) offered several possibilities. First, it is likely that the unexpectedly good or poor performance prompts individuals to search for likely sources. This view was further supported by Pyszczynski and Greenberg (1981) who demonstrated that individuals are highly likely to engage in thorough attributional processing following unexpected events compared to expected events. Attributional processing, in this context, involves an individual assigning the cause of behaviour to an event that is outside one's control, rather than an internal characteristic. Second, Nisbett and Ross (1980) suggested that it is likely that the initial impression of either a good or poor performance induces an individual to generate additional evidence that can lead to confirmation of the impression. This has been described in more recent studies as confirmation bias (Cipriano & Gruca, 2014). Collectively, the attribution and confirmation bias leads to individuals constructing frameworks of cognition prior to the debriefing process that perform a role in discrediting the evidential basis of the belief (Critcher & Dunning, 2011). In such a case, the impact of earlier information remains intact. In other words, the individual continues to maintain a set of cognitions that leads to the generation of erroneous inferences and predictions, even after debriefing. These views are parallel with the conclusion that the consideration of alternative hypotheses corrects numerous social judgement biases (Lord, Lepper, & Preston, 1984; McFarland, Cheam, & Buehler, 2007).

One of the ways to overcome belief perseverance is the use of counterarguments. The use of counterarguments is meant to reduce one's confidence in an existing belief, hence increasing the chance that a compelling explanation will help in initiating the process of revising existing views (Burke, 2006). The efficacy of counterarguments in overcoming belief perseverance has, however, been a subject of debate. Koehler (1991) concluded that, although counterarguments can help reverse the effects of prior explanations, it is likely that some impressions from the original belief are still retained. In other words, counterarguments only assist in reducing the strength of existing beliefs, as opposed to completely overcoming them. While corroborating such views, Woll (2001) found that despite efforts to overcome belief perseverance, initial views continue to dominate later explanations. In the present experiment, the role that circadian variations perform in overcoming belief perseverance is critically investigated.

### **1.5 Belief Perseverance and Circadian Variations**

Prior studies are yet to investigate the potential influence that circadian variations could have on an individual while revising the existing biased beliefs in light of discrediting evidence. However, Some studies have suggested that cognitive efforts play a role in belief perseverance. Gilbert (1991), for example, highlighted that believing occurs more automatically compared to revising. In other words, less cognitive efforts are required in the acquisition of a belief compared to revising the belief. This helps in explaining why many beliefs have been shown to outlive the data that is used to discredit them. Similarly, Guenther and Alicke (2008) argue that belief perseverance tends to occur because people spontaneously construct causal stories that help reinforce the belief while refraining from engaging in a more deliberate cognitive process to revise the invalidated information.

Cognitive bias could also influence the extent of belief perseverance. As Friedman (2004) explains, one of the areas where cognitive bias occurs pertains to situations affected by availability and primacy. Availability describes the tendency for people to judge the probability of a certain event based on the ease with which examples relevant to an event are remembered. Therefore, information that is provided first in a given sequence (primacy effect) is likely to have a high influence on decision-making (Burke, 2006; Friedman, 2004). Taken into the context of circadian variations, it could be argued that the subjects tested at their circadian congruent times have greater availability of cognitive resources that play an important role in helping overcome cognitive bias and primacy effect.

From yet another perspective, the dual process view of cognition can be used to possibly explain the underlying reasons behind belief perseverance. This approach is yet to be incorporated in belief perseverance, but has wide application in other related fields that focus on examining memory, reasoning and judgement in decision making (Kahneman, 2003; Evans & Stanovich, 2013). The dual process of cognition makes a distinction between two kinds of thinking: intuitive/heuristic (System 1) and deliberate/analytical thinking (System 2). Intuitive thinking is fast, autonomous and makes little use of working memory. This kind of thinking has also been described as automatic, contextualised, associative, relies on experience-based decision-making, unconscious and is made independent of cognitive ability. By contrast, analytical thinking is conscious, controlled, rule-based, entails consequential decisions and is negatively correlated with cognitive ability (Evans & Stanovich, 2013; Kahneman & Frederick, 2002). Therefore, analytical thinking, unlike intuitive thinking, makes use of working memory, requires mental simulation and complex emotions.

Within the above context, belief perseverance is associated with people failing to thoroughly consider alternative explanations/hypotheses. Therefore, it could be argued that belief perseverance is likely to be high among individuals characterised by System 1 type of



thinking that operates independent of working memory. In contrast, individuals characterised by lower levels of belief perseverance, after counterarguments or discrediting evidence, are likely to make use of System 2 type of thinking, that is more deliberate. Testing of participants at their circadian congruent time increases the chance that analytical thinking will be utilised. It is thus expected that individuals tested at their circadian congruent times are characterised by greater willingness to revise their beliefs compared to those tested at circadian incongruent times. It should, however, be noted that although the dual process view of cognition enjoys significant empirical support, it is not without criticism. It has, for instance, been argued that some tasks that require System 2 thinking could, over time, become habitual and automated, and hence makes use of System 1 processes (Evans, 2008). In addition, some decision-making contexts may necessitate a mixture of System 1 and 2 thinking processes (Evans & Stanovich, 2013).

From another perspective, Bodenhausen (1990) demonstrated the potential impact of circadian variations on judgements through research on stereotype making. The study hypothesised that, during circadian incongruent times, individuals experience a constraint on cognitive resources that, in turn, predisposes them to rely on judgemental heuristics during decision-making. The results of the study demonstrated that stereotype judgements depicted predictable diurnal patterns. Specifically, morning type individuals were found to rely more on heuristics for stereotype judgements when tested during evening hours. Similarly, evening type persons relied more on stereotype judgements when tested during the morning hours (Bodenhausen, 1990).

### **1.6 Socially Distributed Thinking/Cognition**

Research on social psychology and situated cognition has, over the years, laid a foundation for broader investigations on socially situated cognition (SSC). SSC is based on the premise that, besides influencing the content of thought, social objects also shape the

processes that underlie thoughts and behaviour (Smith & Semin, 2004). Four themes are captured in the SSC approach and include cognition as action-oriented, cognition as an aspect that is embodied, cognition as situated, and cognition as socially distributed (Mitchell, Randolph-Seng, & Mitchell, 2011; Semin & Smith, 2013). The present experiment focuses on the dimension of cognition as a process that can be socially distributed. Within this perspective, Smith and Semin (2013) posit that cognition can be distributed across social agents such as groups and the environment. Similarly, Cornelissen and Clarke (2010) found that speaking and interactions that occur in a group context have an influence on how individuals construct meaning pertaining to an aspect of interest, such as the development of a new venture. The two scholars further found out that entrepreneurship ideas that arose from social context interactions were likely to be characterised by high levels of sense making that were instrumental to the venture success. Along similar lines, West (2007) found that collective cognition is distinct from individual cognition. The study elaborated that, unlike individual cognition, collective cognition tends to have a more superior impact on decision-making.

The hypothesis of extended cognition (HEC) also provides useful insights pertaining to the mechanisms inherent in socially distributed cognition. HEC suggests that the human cognitive processes are not limited to an individual's brain. Rather, they span across the body and the external world (Spaulding, 2011). In greater detail, the hypothesis indicates that cognitive processes and systems are spatiotemporally spread in such a way that extra neuronal elements from the external world closely work with the internal elements to give rise to the cognitive system (Clark, 2008; Sutton, 2010; Wilson, 2010). The extra neural resources may be in the form of other groups of individuals and learning aids, playing an important role in aiding, sculpting or augmenting cognition (Kirchhoff, 2014). Other objects that constitute part of the external environment include calendars, books and personal

computers. Based on HEC, these objects help provide intimate feedback to an individual's thought processes and guide actions in direct, and in some cases, undeliberated ways (Sprevak, 2010). The implication is that when individuals are confronted with tasks that require cognitive effort, they are likely to take advantage of processes, structures and objectives that provide additional cognitive support.

Hutchins (1995) provided one of the most popular illustrative examples of how socially distributed cognition works. In the study *Cognition in the Wild*, the author described how the successful navigation of large ships emanates from a complex cognitive system. The navigation of the ship involves several persons and their artefacts as opposed to a single individual. In order to carry out the complex and delicate task, the marine staffs collaborate in taking the bearing of other ships, landmarks and buoys. The bearings are then communicated to staff in the pilothouse and subsequently marked on charts to provide accurate directions. An individual cannot do this cognitive task independently (Hutchins, 1995).

The need to investigate the influence of socially distributed thinking on belief perseverance in the present study is a result of several factors. First, feedback from other individuals has been shown to play an important role in influencing the decision-making processes (Blanchette & Richards, 2010; Xue, Lu, Levin, & Bechara, 2010). Second, judgements in most cases are not discrete events that have no history or future. People have a habit of frequently sharing their judgements with others. The feedback received may be used to make judgements as to whether one is on the right track (Glockner & Witteman, 2010). If the discussion reveals that a judgement is wrong, then there is a high chance that the person or group will change the existing view through consideration of additional information. Alternatively, the feedback can be used to change the process of reaching a certain conclusion. As such, it is expected that individuals in a group context are more likely to

attenuate previous biased beliefs in light of new discrediting information. This can be attributed to a greater amount of cognitive capacity that is available to critically consider the credence of counterarguments or evidence.

While taking the above views into consideration, some research exists on the potential influence of group discussion on decision-making. Wright and Wells (1985) found that group discussion significantly attenuates attribution errors which entail the generation of distorted perceptions about other individuals or objects under consideration. In a latter study, Wright, Christie, Johnson, and Stoffer (1996) further found out that group discussions have a major influence on the elimination of consensus underutilisation effect, which is the tendency for group discussion moderators to underuse consensus information. In the consensus underutilisation effect, an individual is likely to give insufficient weight to information leading to inaccurate judgements. In experiments involving multiple cue judgements, whereby decision makers are confronted with multiple information cues that must be combined to make an overall judgement, groups demonstrated better performance in terms of accuracy when compared to individuals (Olsson, Enkvist, & Juslin, 2006).

Through distributed information processing, it has also been shown that groups are better placed to approach problems in a highly structured manner that is aided by external cognitive artefacts (Wilcox, 2008). In a similar study to that conducted by Wilcox (2008), Chidambaram and Tung (2005) showed that the presence of inputs from different members of a team improved the chances that a complex problem would be well understood compared to an individual working alone. It should, however, be noted that not all cases of socially distributed thinking are likely to lead to better judgements compared to individual cognition.

Research on social loafing, for example, indicates that some members of a group may exert less effort on the task at hand leading to the lacklustre performance of the overall group (Chidambaram & Tung, 2005; Blaskovich, 2008). An example of social loafing occurs when

some students working collectively on an assignment put less effort since they will receive one grade for the assignment. The same students, however, make more effort when an assignment requires one to work individually.

While taking into consideration belief perseverance, an individual's initial impression of a certain subject, or another person, may be biased and erroneous. Such bias may reflect a preference for specific dispositional inferences even in a context where strong discrediting information exists (Jelalian & Miller, 1984). It may have negative implications in certain contexts, such as legal judgements and politics. Accordingly, it is important to understand the conditions under which biased impressions are retained or abandoned in the presence of new information that offers contradictory evidence. Accordingly, the present study contributes in this field by investigating circadian variations as one of the conditions that influence belief perseverance. Prior studies are yet to investigate the relationship between the two variables, and hence an opportunity to provide new insights from a social psychology perspective.

### **1.7 Information Accessibility/Type of Reasons Given and Belief Perseverance**

Several studies have examined the impact that ease of retrieval affects attitude-based judgements. In a study on the availability of heuristics, Schwarz et al. (1991) asked the study participants to recall instances where they had behaved assertively. The participants were to recall either 6 or 12 instances. A pre-test of the study found that the majority of participants experienced greater ease in recalling 6 instances, as opposed to 12 instances. Following the completion of this task, the participants were further asked to rate their level of assertiveness. Ideally, if the participants' judgements were determined by the content that, in this case, is the number of recalled instances, and then it would be likely that individuals who recalled 12 instances would express higher levels of assertiveness. However, Schwarz et al. (1991) made the prediction that judgements made by the participants were determined by the subjective ease of conducting the retrieval task. Therefore, higher ratings of assertiveness were expected

among participants who were asked to recall 6 behaviours. The final results of the study were consistent with Schwarz et al.'s (1991) prediction leading to the conclusion that individuals can rely on the ease with which they generate information in their mind to form judgements.

In support of the above findings, Wanke, Bless, and Biller (1996) found that participants had more favourable attitudes towards the use of public transport when they experienced the ease of generating supporting arguments or experienced difficulties in generating counterarguments. Another key finding of the study was that participants expressed greater confidence in their attitude when they had an easier time in generating supporting arguments (Wanke et al., 1996). Haddock, Rothman, and Schwarz (1996) also conducted a similar study, in which case, participants were required to generate either 3 or 7 arguments that either supported or opposed the issue of doctor-assisted suicide. From the study results, the majority of the participants had an easier time recalling three arguments, but found it difficult to recall seven. After completion of the task, the participants were further requested to rate the intensity, certainty and importance of their views towards the issue of doctor-assisted suicide (Haddock et al., 1996). The predictions were that, if the participants used the ease or difficulty with which they could bring material to mind as their source of information, they would report higher levels of certainty, intensity and importance following a recall of 3 rather than 7 supporting arguments, or recalling 7 rather than 3 opposing arguments. The results of this second part of the study were consistent with the predictions. In particular, the participants depicted stronger attitudes towards the issue when they had an easier time retrieving supportive arguments or difficulty in retrieving opposing arguments. Collectively, the studies by Schwarz et al. (1991), Wanke et al. (1996) and Haddock et al. (1996) demonstrate that attitude judgements can be influenced by the ease or difficulty with which attitude-relevant information comes to one's mind.

More recently, Nestler (2010) investigated the role that accessible context and accessibility experiences performed, with respect to overcoming belief perseverance. The study was undertaken in the form of two experiments, in which case, participants were tested with regard to whether accessibility experiences had an influence on belief perseverance when participants generated few or many reasons with regard to how a reported/original outcome or its alternative would have turned out. Among participants in Experiment 1, who had listed many reasons for the reported outcome, the majority considered this outcome to be less likely after debriefing was performed. The conclusion, therefore, was that the participants did not exhibit belief perseverance, compared to those who had provided fewer reasons. By contrast, Experiment 2 found that participants who provided many reasons for the alternative outcome indicated that the reported outcome would be more likely. They therefore exhibited higher levels of belief perseverance compared to individuals who had listed a few reasons (Nestler, 2010).

Traditionally, attitudes were conceptualised as being stable evaluative responses pertaining to an issue or attitude object (Eagly & Chaiken, 1993). The implication of this perspective is that attitude judgements should not be influenced by the context or environment in which they are completed. Currently, this view has been contested with theorists postulating that it is possible that attitudes are formed on the basis of information or data that is temporarily available and accessible during the time of judgement making (Cone & Ferguson, 2015). Therefore, attitude judgements, such as those that revolve around belief perseverance, can be affected by the context in which they are reported. Within this perspective, Wilson, Lindsey, and Schooler (2000) demonstrated that thinking about the reasons behind one's attitude could produce attitude change (e.g. attenuation of belief perseverance). In the present study, change in attitude is investigated with respect to belief

perseverance with circadian variations being the context within which differences in belief perseverance attenuation are likely to occur.

Based on Experiment 1, in the study by Nestler (2010), it is expected that participants tested at their circadian incongruent times would have less cognitive resources available. Generation of reasons should, therefore, be more difficult. When an individual experiences difficulties in generating the reasons in favour of a known outcome, he or she should rethink and initial judgement and change their mind. Therefore, it is expected that less perseverance should occur under incongruent thinking. By contrast, it could be assumed that, when participants are tested at their circadian congruent times, they would find it easier to generate reasons for the outcome due to the availability of a greater degree of cognitive resources. It is thus expected that belief perseverance should increase under congruent thinking when individuals are asked to generate reasons supporting the outcome. In Experiment 2, it is assumed that generating reasons against the alternative outcome would be hard when participants are tested at their circadian incongruent times due to unavailability of cognitive resources. In such a case, it is likely that participants should revert to their original belief and hence demonstrate increased belief perseverance. When tested at their circadian congruent times, the participants should find it easier to generate reasons against as they have more cognitive resources for doing so. Therefore, the current study expects that less belief perseverance is expected for congruent thinking when participants are asked to provide reasons against.

### **1.8 Belief Perseverance in a Legal Context**

The legal environment such as courtrooms constitutes as one of the areas where the impact of belief perseverance could have important ramifications. According to Jelalian and Miller (1984), the sequential stream of information presented in the form of assertions and counterarguments makes the courtroom an obvious area where possibilities for belief



perseverance are elevated. For example, the court may use the testimony of an eyewitness who is later judged to be unreliable due to the discredited information provided. Loftus (1974) demonstrated an incident when the court verdict was influenced by the account of an eyewitness who was later found to have extremely poor vision. The poor vision rendered the testimony offered by the witness logically untenable. Although the aggrieved parties were briefed about the condition of the witness, they still held onto the earlier judgement about the guilt of the suspect. It is, on this basis, that Loftus and Monahan (1980) recommended the presence of psychologists with social perception and memory expertise to be used as expert witnesses to help identify unreliable eyewitnesses in courtrooms.

Several lines of research have, however, shown that belief perseverance may not always hold in court settings. Hatvany and Strack (1980), and McCloskey and Egeth (1983), for example, failed to observe perseverance effects in jury simulation experiments. In these cases, the subjects were able to discount initial testimonies that were subsequently discredited. There have been attempts to explain the possible basis for the absence of perseverance effects. Haddock and Maio (2004) explain that, in courtrooms, the various parties usually have prior expectations in relation to the validity of information. Therefore, the different parties in the courtroom are likely to consider alternative outcomes and causal explanations before they can form stable beliefs. Another explanatory argument is that in most belief perseverance studies, the participants usually receive information that often entails an unfamiliar domain (such as detection of authentic suicide notes) from an individual considered to be a highly credible source. As a result, the study participants often have little reason to suspect the presence of inaccurate information. By contrast, court proceedings are such that the parties are aware that some witnesses may not be truthful in their testimonies (Schul & Manzury, 1990). Such awareness constitutes a warning that deception may arise, and hence the affected parties may require less effort in attenuating initial beliefs.

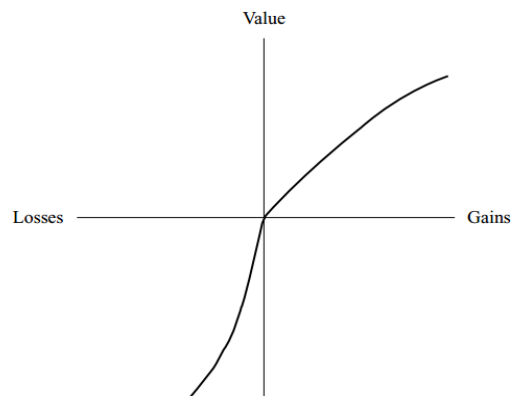
### **1.9 Framing Effects and the Classic Asian Disease Problem**

Most important decisions that individuals make involve some risk (Dovidio, Piliavin, Schroeder, & Penner, 2017). As a result of the implications of risks, a substantial body of research has sought to understand approaches used by decision-makers to incorporate risks into their choices. Research has, for example, shown that risk aversion behaviour among individuals contributes significantly to an understanding of diverse economic and legal problems in areas such as portfolio selection, insurance issues and contracting (Lim, Sherali, & Uryasev, 2010).

Theoretically, existing models on risky choices indicate that individuals tend to value a risky prospect, such a lottery, by some type of weighted average scheme. In other words, individuals, when presented with risky choices, are likely to balance the chances of relatively good and poor outcomes (Bellemare & Shearer, 2010). For example, an individual might be faced with two prospects in which one prospect involves two events (uncertain) and the other prospect involves a single event (risky) that has the same probability structure. In this case, the decision maker will require a higher return on the uncertain prospect since he subjectively views it as riskier. This might occur in a situation where an individual has the option of investing in one country with a weak institutional environment, and another with a stronger institutional environment. In this case, the investment in the institutionally weaker country is considered as riskier, and hence will require a higher return compared to the other country.

Within the above context, there is a general consensus that individuals usually consider the implications of good or poor outcomes while making risky choices (Kühberger & Tanner, 2010; Mahoney, Buboltz, Levin, Doverspike, & Svyantek, 2011). Prospect theory, however, suggests that presentation/framing of the outcomes as either a loss or gain may affect the amount of risk that an individual is willing to accept (Gneezy, List, & Wu, 2006). This effect has been attributed to differences in perceived subjective value, and is explained through the

S-shaped value function. The function is concave for gains, thus implying outcomes that are presented, as gains are likely to lead to risk-averse preferences. It is convex for losses, thus providing that outcomes framed in loss terms leads to preferences for risky alternatives (see Figure 1.1<sup>1</sup>) (Levy & Levy, 2002). Simply put, decisions about gains lead to risk aversion, while decisions about losses lead to risk-seeking behaviour, even in instances where both outcomes are similar. It also implies that an individual's preference towards risks will depend on whether a choice is made in the domain of gains or in the domain of losses. For example, presenting an individual with a gamble in which \$110 can be gained or \$100 lost with equal probabilities will most likely lead to rejection of the gamble.



**Figure 1.1:** The S-value function for gain and losses in the Prospect Theory (Bloomfield, 2006)

Framing effects tend to violate the invariance axiom as explained in expected utility theories. The axiom indicates that choices are expected to be the same across situations where all outcomes are transformed in the same way. As such, framing effects depict irrational behaviour among the affected individuals (Tversky & Kahneman, 1986). The basis of risky choice framing is, therefore, that “how” something is expressed has a more significant

<sup>1</sup> Prospect theory's value function for gains and losses was originally adopted from Kahneman and Tversky (1979).

influence on the evaluation of information than “what” is said (Levin, Schneider, & Gaeth, 1998).

The Classic Asian Disease problem constitutes as one of the most popular and widely used examples of framing effects. In this experiment, participants were informed that there would be an outbreak of an unusual Asian disease that would kill 600 people. The participants were required to choose from two alternatives to combat the disease from Positive and Negative frames. In the Positive frame, adoption of Program A would lead to 200 people being saved; while in Program B, there was a 1/3 probability of 600 people being saved, and a 2/3 probability that no people would be saved. In the Negative frame, adopting Program C would lead to 400 people dying, while in Program D there was a 1/3 probability nobody would die and a 2/3 probability that 600 people would die from the disease. Notably, Program A and C were equivalent in terms of possible outcomes, as are Program B and D. The study, however, found that 72 percent of individuals responding to the Positive frame chose the certain option of Program B. On the other hand 78 percent of individuals responding to the Negative frame chose the risky option of Program D (Tversky & Kahneman, 1981). The rationale behind the choice of program B and D is that rational individuals tend to engage in the risk-taking behaviour when they are presented with a Negative/risky frame. Similarly, they are more likely to avoid risks and uncertainties when presented with a Positive frame. This framing effect has been tested in other studies and found to be enduring (Gonzalez, Dana, Koshino, & Just, 2005; Levin, Gaeth, Schreiber, & Lauriola, 2002; McElroy & Dickinson, 2010). Some studies (e.g. Peters & Levin, 2008) have, however, demonstrated the absence of significant framing effects when alternatives are framed in Positive versus Negative terms.

Framing effects manifest themselves in a variety of ways in real-life contexts. In the field of politics, existing work indicates that framing of political issues significantly influences public opinions. Slothuus and De Vreese (2010), for example, found that supporters of a

certain party were likely to depict bias towards a certain political issue if it was sponsored and framed by their party. De Vreese, Boomgaarden, and Semetko (2010) also found significant framing effects in a study that sought public opinions on support for the admission of Turkey into the European Union. The results of the study showed that negative news frames about Turkey yielded stronger effects compared to Positive news frames. In other words, the level of public support for Turkey varied significantly, depending on whether the respondent was exposed to a positively or negatively valenced news frame. Similar effects have been reported in studies on climate change. Americans were, for example, shown to think differently about the benefits of deep sea oil drilling when the issue was expressed, in terms of the country's continued dependence on foreign energy sources as opposed to the economic costs of failing to develop newer and greener sources of energy (Zaller & Feldman, 1992). Collectively, these studies suggest conceptual clarity of information influences its interpretation among the targeted audience. They also provide evidence on the capacity for Positive and Negative frames to shape public opinions on certain important matters.

### **1.10 Circadian Preferences on Framing Effects**

The presence of circadian preferences provides possible explanations for the presence of framing effects among individuals. However, previous attempts to investigate this area have only been indirect in nature. For example, some studies have suggested that the cognitive effort that an individual puts towards examining a question could have an influence on framing effects. Cacioppo and Petty (1982), for instance, studied need-for-cognition (NFC) and its influence on framing effects. The study found that individuals depicting high levels of NFC put more effort in processing tasks, while individuals with low NFC used less effort. Similar research has demonstrated that individuals who have a high NFC are characterised by lower framing effects (Smith & Levin, 1996; Chatterjee, Heath, Milberg, & France, 2000; Curseu, 2006).

In addition to NFC, high depth of cognitive processing and mathematical ability has been shown to reduce framing effects (Simon, Fagley, & Halleran, 2004). Through a Cognitive Reflective Test (CRT), Frederick (2005) further found that the effects of risky-choice framing were attenuated among individuals who relied on more conscious and deliberate processes. The effects were robust among individuals who relied on more automatic processing. Oechssler, Roider, and Schmitz (2009) also reported similar findings, and found that individuals with higher cognitive abilities were characterised by lower incidences of biases and conjunction fallacy. This occurs when an individual assumes that multiple specific conditions are more probable than a single general one.

To conclude, the above studies suggest that the factors which affect the level of conscious and deliberate processing of information are likely to influence framing effects. Within this context, research, as mentioned earlier, suggests that individuals tested at circadian congruent times are more likely to engage in more effortful thinking due to the optimal availability of cognitive resources (Böckenholt, 2012; Wieth & Zacks, 2011). It is therefore expected that individuals tested at their circadian congruent times are likely to depict lower levels of framing effects, compared to individuals tested at circadian incongruent times. This constitutes one of the aspects that the present study seeks to investigate in greater detail.

Another stream of research investigates framing effects from the context of decisional situations. One study suggests that framing effects can be linked to mental models relied upon by the individual during decision-making. An individual is predisposed to make decisions through a comparison of the information used to describe a current situation and pre-existing cognitive representations of a similar situation that are activated from the long-term-memory (Gigerenzer, Hoffrage, & Kleinbolting, 1991). In another study, Olekalns and Smith (2005) demonstrated that, framing effects, in part, arose from the presence of alternatives that were embedded in an individual's cognitive causal schema. The way in

which the alternatives are presented to a person tends to activate congruent schema from the long-term memory that, in turn, influences the selective processing of information during decision-making. Olekalns and Smith (2005) further used the example of cooperative and uncooperative negotiators. In the case of cooperative negotiators with the same orientation dyad, they tend to place greater emphasis on cooperation, flexibility and trust. On the other hand, competitive negotiators focus mainly on competition. The outcome is that negotiators in the same orientation are likely to report a more positive experience compared to negotiators in mixed-orientation dyads. Taken in the context of circadian variations, this would mean that individuals tested at circadian incongruent times are more likely than their counterparts tested at circadian congruent times to depict framing effects. This can be attributed to selective processing of information that arises from fewer cognitive resources that are available during ones non-peak hours.

From yet another perspective, framing effects are associated with higher sensitivity levels of human cognitive systems to information that is negatively presented. In particular, framing a situation in negative terms triggers a well-established negativity bias in human cognition to truth judgements (Acton, 2013). During the impression formation process, the expectancy that confirms negative information tends to override the effect of news confirming positive information. For example, information that points towards the materialisation of a threat expected by an individual outweighs information that signals hope (Lupfer, Weeks, & Dupuis, 2000). While attempting to explain such behaviour, some authors have argued that people are willing to allocate more cognitive resources to process information that has elements of danger or threats. Interestingly, the same individuals depict reluctance in allocating resources to positively framed information (Miclea & Curseu, 2003). Human cognition is, therefore, such that individuals are more likely to consider negatively framed statistical statements as true compared to equivalent statements that are positively framed.

The underlying processes that influence this effect are yet to be sufficiently understood. The present experiment seeks to improve the level of understanding in this area by investigating the role performed by circadian variations.

Individual differences in framing effects have also been studied. One of such areas pertains to impact of age on framing effects. Several studies suggest that the ageing process after midlife appears to have a negative effect on a variety of intellectual abilities such as memory, reasoning and attention (Zacks, Hasher, & Li, 2000; McDowd & Shaw, 2000). However, Mayhorn, Fisk, and Whittle (2002), in a study that was based on the Asian Disease problem, found no age-related differences in choice of preferences. The study thus concluded that individuals of all ages are susceptible to framing effects.

### **1.11 Present Experiment – Aim, Objectives and Hypotheses**

The dissertation is structured in terms of three experiments. In the first experiment, the primary aim pertained to (1) examining the cognitive processes that influence an individual's belief perseverance, and (2) examining the moderating role that circadian variations and socially distributed thinking have on cognitive processes that impact on belief perseverance. In order to meet these aims, participants were required to take part in a forensic based experiment. The participants were provided with a description of stereotypical suspect assumed to be guilty of committing an offense. After making their initial judgements, the participants were debriefed by being provided with an atypical offender profile in the form of counterevidence from an expert profiler. The participants were then asked to revise their initial judgements in relation to the extent to which the suspect was guilty. The participants were separated into two groups. One group was tested based on their circadian congruent times, while the other half of the participants were tested based on their non-optimal circadian incongruent times.



From the review of prior studies on circadian variations, it was expected that individuals tested at their optimal circadian congruent times would experience less belief perseverance compared to individuals tested at their circadian incongruent times. This should be the case, since the higher cognitive resources availability during circadian congruent times allow for more deliberative thinking that helps in revising prior information that may be biased. Furthermore, due to the positive impact of socially distributed thinking on complementing individual cognitive resources, it was expected that groups would depict less belief perseverance compared to individuals when tested at their circadian congruent times. The following hypotheses are therefore tested:

H1a: Belief perseverance is significantly less when participants are tested at their optimal time of circadian preferences compared to testing at circadian incongruent times.

H1b: Participants in a group will depict significantly less belief perseverance than individuals when tested at their optimal time of circadian preferences.

The second study complements the first study by incorporating the effect of type of reason given on the relationship between belief perseverance and circadian preferences in a legal context. The study thus focuses on the decision-making context under which belief perseverance occurs. It makes use of two experiments conducted by Nestler (2010) on the role of accessible content and accessibility experiences on belief perseverance. While taking into consideration the testing of participants at circadian incongruent times, it is expected that difficulties would be experienced in the generation of reasons that support the original belief due to lower availability of cognitive resources. Therefore, the participants are motivated to rethink their initial judgement hence producing higher chances that belief perseverance will be attenuated compared to individuals tested at their circadian congruent times. For the alternative outcomes, it is expected that the generating of reasons against should be difficult when testing is performed at circadian incongruent times. The participants should, therefore,

revert to their original belief and hence depicting more belief perseverance. In contrast, generating reasons against should be easier when individuals are tested at their circadian congruent times, leading to the attenuation of belief perseverance. The corresponding hypotheses are as follows:

H2a: Participants tested at their circadian incongruent times find it significantly difficult to generate reasons in favour of a known outcome, and hence less belief perseverance.

H2b: Participants tested at their circadian congruent times find it easier to generate reasons in favour of a known outcome, and hence more belief perseverance.

H2c: Participants tested at their circadian incongruent times find it more difficult to generate reasons against a known outcome and hence more belief perseverance

H2d: Participants tested at their circadian congruent times find it significantly easier to generate reasons against a known outcome, and hence less belief perseverance.

The third study further extends the research on circadian effects by examining the potential influence on framing effects in the context of the Classic Asian Disease Problem by Tversky and Kahneman (1987). Prior research, as evident from the literature review, has reported mixed findings on the factors influencing framing effects. In order to provide additional clarity in this area, the study investigates whether Morningness-Eveningness orientation, based on circadian preferences of the participants, influences decision-making and consequently framing effects. One of the related studies by Bodenhausen (1990) demonstrated that framing effects in the context of stereotyping are more evident when participants are tested at their circadian incongruent times, than when tested at their circadian congruent times. The moderating effects of circadian variations in risky choice framing are however yet to be conclusively investigated. Thus, the present study investigates whether framing effects in the context of the Classic Asian Disease Problem are moderated by circadian preferences. In relation to the literature the following hypotheses are tested:

H3a: Participants tested at their circadian congruent times are less susceptible to framing effects in the Asian Disease Problem.

H3b: Participants tested at their circadian incongruent times are more susceptible to framing effects in the Asian Disease Problem.

## **Chapter 2: The Role of Circadian Variations and Socially Distributed Thinking in Belief Perseverance**

### **2.1 Chapter Introduction**

#### **2.1.1 Study Background**

The past few decades have been marked by an increase in research regarding the tenacity with which individuals maintain their beliefs or attitudes in the face of discrediting evidence (Nestler, 2010; Beaulieu & Reinstein, 2010). It is common for people to believe that many things are likely to be untrue. However, they are not always able or willing to revise the previous beliefs about the false information (Savion, 2012). For example, an individual who believes that swimming right after a meal will lead to a bad stomach cramp is likely to hold on to this view even after evidence that refutes such a belief has been provided. This phenomenon is referred to as belief perseverance. It describes an individual's biased response to information as a way of maintaining an existing conception (Green & Donahue, 2011).

Two of the main lines of research on belief perseverance include: perseverance in the presence of discrediting evidence, and perseverance after assimilation of information that is closely related to an individual's initial belief (Goodwin, 2009). This study focuses on perseverance in the presence of discrediting evidence.

In an attempt to explain the belief perseverance phenomenon, some studies have suggested that individuals tend to engage in the search and recollection of information that is consistent or in support of an existing impression (Cook, Ecker, & Lewandowsky, 2015). This aspect has been referred to as behavioural confirmation, and is characterised by an individual depicting self-fulfilling processes. The implications of belief perseverance are evident in many real-life contexts. These include the undesirable effects of false accusations in the media, jurors being influenced in their decisions by discredited eyewitnesses and stability in the liking and dislike in the responses provided by others (Green & Donahue, 2011).

There have been several attempts to alleviate belief perseverance, albeit with limited success. One of such attempts involves generation of counter-explanations to the initial belief. Anderson (1982, 2007), within this context, argued that since generating an explanation can bolster a given belief, and a counter-argument could also help in reducing one's confidence concerning the belief under consideration. However, the extent to which counterarguments are effective in helping to overcome the initial belief perseverance effect has been a subject of debate.

Arguably, the limited success of counterarguments in alleviating belief perseverance can be accounted for with the help of the dual process view of cognition. Although this process is yet to be widely incorporated into studies on belief perseverance, it has been used in related fields that examine memory, reasoning and judgement. The dual process view of cognition is based on evidence indicating that people tend to neglect base rates and engage in biased judgements in a wide range of tasks and situations (Gilovich et al., 2002). In a bid to explain such occurrences, the dual process view indicates that they are two types of thinking: System 1 (intuitive/heuristic thinking), which is characterised by processing that is fast, autonomous and requires little working memory; and System 2, (deliberate/analytical thinking), in which processing puts a heavy load on memory, operates consciously, is largely controlled and slow (Stanovich & Toplak, 2012).

From the dual process view of cognition, belief perseverance can be linked to System 1 thinking that is intuitive or heuristic. By contrast, individuals engaging in System 2 thinking, which is analytical, are less likely to be affected by belief perseverance. This is expected since analytical thinking is done consciously and deliberately. As such, it can be further expected that belief perseverance is likely to decrease in situations that are characterised by higher demand for analytical thinking. The present study seeks to examine the possibility of such occurrence, by investigating the potential role that is performed by variations in

cognitive resources on belief perseverance. The examination is based on two aspects: circadian preferences and socially distributed thinking.

While linking the dual cognitive process to circadian variations, it can thus be suggested that, during an individual's optimal time, he or she is likely to engage in more deliberative thinking. In other words, circadian congruence/match will lead to the availability of high-level cognitive resources, which in turn, allow for analytical type of thinking, as opposed to heuristic thinking. By contrast, circadian incongruence/mismatch predisposes one to engage in less conscious thinking. Such thinking requires less effort, and therefore an increase in the chances that it could be biased in nature. Accordingly, the present study hypothesises proves that belief perseverance alleviation is likely to be more successful when individuals are required to revise their prior beliefs, in light of the contradictory evidence, at a time congruent with their circadian preferences.

At the non-optimal time, when an individual's cognitive resources are depleted, belief perseverance may still be alleviated but only through augmenting of such resources (Dickinson & McElroy, 2012). The aim, in this context, is to counter the effects that circadian variations have on the cognitive efforts made in analysing a given situation. In the present study, this possibility of augmenting cognitive resources at a non-optimal time were tested through an examination of the influence of socially distributed cognition on belief perseverance. The concept of socially distributed cognition can be explained through the Hypothesis of Extended Cognition (HEC).

In brief, HEC claims that important aspects of an individual's mental life tend to spill outside one's thoughts into objectives in the environment (Sutton, Harris, Keil, & Barnier, 2010). This hypothesis further suggests that human cognition is supported by opportunistic, soft-assembled hybrid associations of neural, bodily and environmental elements (Sterelny, 2010). Meaning an individual's brain is likely to take advantage of processes and structures

that can help support its cognitive resources. Distributed cognitive, therefore, treats the activity system rather than the individual as the main unit of cognitive analysis (Michaelian & Sutton, 2013). The activity system takes into account the external environment under which an individual operates, as well as interactions with other individuals (Hazlehurst, Gorman, & McMullen, 2008). Hutchins (1995) provides one of the influential accounts of how socially distributed cognition works. Using the example of a ship's navigation, Hutchins (1995) explained that the navigation process is, to a large extent, a cognitive process, in the sense that it leads to the representations of the ship's positions in its environment. Among the members of the crew, no single individual can perform the complex navigational task alone. Instead, the task is undertaken by the interaction of many individuals with the help of technical instruments.

In a group context, socially distributed cognition enhances information processing capabilities of the members, and therefore increased ease of making decisions in complex situations. Through socially distributed thinking, individuals can exploit the performance strengths of individual cognition in aspects such as hand-eye cognition, while at the same time avoiding its weaknesses such as emotional interference (Brown & Duguid, 1991). Boland and Tenkasi (1995) also found that the inputs from different members of a team significantly increase the chances of understanding a complex problem compared to an individual acting alone. Such superior performance among individuals working in a group is further attributed to the possession of complementary knowledge (Yoo & Kanawattanachai, 2001).

Some studies have however underscored that socially distributed thinking may not always result in enhanced cognitive resources that yield superior performance. According to List (2008), socially distributed thinking provides better performance outcomes when two key conditions are met. First, the group should be such that it is a well-demarcated system.

Second, the group must count as a system that is capable of producing cognitive outputs. The first condition can be achieved only when the group's collective behaviour is well integrated. For example, a well-organised group of scientific collaborators are likely to benefit from socially distributed thinking compared to a random group of people. For the second condition, the group should be such that it is capable of producing outputs that offer a representational content or collective judgement. This can be achieved by ensuring that the group has a formal structure that allows for joint declarations (List, 2008). Steiner (1972) also found that performance in a group is dependent on the presence on a fit between the cognitive resources at the disposal of the members, the cognitive demands imposed by the task, the distribution of resources, and process costs associated with interactions. Similarly, Hutchins (1991) suggests that superiority in deliberative thinking in a group context will depend on cognitive resources that are available to the members.

Within the above perspectives, this study also examined the influence of the amount of cognitive capacity available to individuals in a group has in relation to alleviation of belief perseverance. Resource availability to the group members was manipulated through circadian variations. The study hypothesised that members constituting a group would depict less belief perseverance than individuals when tested at their optimal time of circadian preferences. By contrast, it was expected that individuals in a group with limited cognitive resources, through circadian incongruence, would exhibit pronounced belief perseverance.

### **2.1.2 Present Experiment**

The primary aims of this study pertained to (1) an examination of the cognitive processes that influence an individual's belief perseverance, and (2) to examine the moderating role that circadian variations and socially distributed thinking have on the cognitive process that impact belief perseverance. The study's context was a forensic scenario involving a description of a stereotypical suspect considered to be guilty of committing an offense. The



participants were required to revise their initial judgements of the extent to which the suspect was guilty after being provided with counterevidence from an expert profiler in the form of an atypical offender profile. Two sets of participants were involved in producing guilt judgements. These included individual participants and groups of three participants. In parallel to the study's aim, one half of the individual and group participants were tested based on optimal times that were congruent with their circadian preferences and the other half were tested based on non-optimal times that were incongruent with their circadian preferences.

Based on the findings reported in prior studies on circadian variations, it was expected that individuals and groups tested at optimal times would exhibit significantly lower belief perseverance through deliberative thinking, compared to individuals and groups, tested at non-optimal times after presentation with counter evidence. It was also expected that groups, due to the positive impact of socially distributed cognition, would have lower belief perseverance compared to individuals when tested at optimal circadian times.

## **2.2 Method**

### **2.2.1 Data Management**

The existence of missing values of more than 5% in the dataset could lead to a distortion of the results. In this study, no missing values were observed, hence the ability to provide non-distorted results. With regards to normality, a data analysis using the multivariate kurtosis method yielded a value less than 1.96, which is an indicator of normal distribution. The study also relied on the parametric statistic, in which case, the sample data was considered to be from a population that follows a probability distribution. For this reason, parametric tests which include *t*-test and analysis of variance (ANOVA) were used.

### **2.2.2 Participants**

A total of 129 participants from Kingston University (students and administrative staff members) participated in the study. Two sets of participants were randomly chosen. They

were either tested individually ( $N=32$ , Mean age = 29 years,  $SD = 12.85$ , 22 women), or in one of 32 small groups comprising of three to four individuals. An individual was only allowed to participate in one group. Table 1.1 provides a summary of the group demographics.

**Table 1.1: Group Demographics**

<b>Group type</b>	<b><i>N</i></b>	<b>Mean age (<i>SD</i>)</b>
Women only	5	25 (9.33)
Men only	3	22 (2.46)
Mixed (2 women/1 man)	12	23(6.65)
Mixed (1 woman/2 men)	12	23 (5.60)
Total	32	23 (6.48)

### 2.2.3 Design

A 2x2x2 mixed design experiment was used. Participants were categorised into two groups comprising of between-subjects and within-subjects. For the between-subjects, the independent variables included testing (congruent circadian preferences and incongruent circadian preferences) and testing conditions (individually or in groups). The independent variable for the within-subject was the time of judgement (before or after being provided with discrediting evidence). Allocation of participants to each of the four conditions was done randomly.

### 2.2.4 Materials and Procedure

Participants took part in a study that examined the process used by jurors to make decisions under diverse circumstances. Prior to making their judgements, the participants were required to complete the online abridged English Version of the Morningness-

Eveningness Questionnaire (MEQ) (rH&O, Chelminski, Petros, Plaud, & Ferraro, 2000). See Appendix A<sub>2</sub>. MEQ validation was conducted by Chelminski et al. (2000) who suggested internal consistency (Cronbach  $\alpha$ ) MEQ was 0.70. The MEQ consists of 5 items to assess the time of day an individual feels the most alert. Participants' responses to each of the items were added up and ranged from 4 to 25. According to the scoring criterion, participants can be classified as 'definitely evening types' (4-7), 'moderately evening type' (8-11), 'neither type' (12-17), 'moderately morning type' (18-21), and 'definitely morning types' (20-25). High scores indicate a greater degree of morningness, while low scores indicate a greater degree of eveningness. Participants who were classified as 'neither type' were excluded from the rest of the study ( $n=4$ ).

On the basis of the questionnaire results, the participants were categorised as either Morning (M) types or Evening (E) types. Such categorisation was achieved through a median split of the participants' scores. M-type participants scored significantly higher on the Morningness-Eveningness dimensions compared to their E-type counterparts;  $M_{M-types} = 17.00$  ( $SD = 3.36$ ),  $N = 34$ ,  $M_{E-types} = 11.57$  ( $SD = 1.36$ ),  $N = 30$ ,  $t(64) = 7.31$ ,  $p < .001$ . After categorisation as either M-type or E-type, the participants were reconvened and required to complete a small questionnaire. One half of the participants were tested at circadian congruent times in which case M-types were tested between 10am and 12noon ( $n=64$ ) while E-types were tested between 1pm and 5pm ( $n=65$ ). The other half was tested at circadian incongruent times.

As part of the process of making judgements, both individual and group participants were first required to read a brief description of a criminal case that entailed a series of sexual molestation of young girls (See Appendix A<sub>1</sub>). Second, the participants were required to read a stereotypical description of the suspect. An example of such a description is a 44-year-old white male who is violent, unemployed, lonely and an underachiever. Lastly, the participants

read an atypical offender profile provided by a forensic expert. This brief description included a spectrum of characteristics that individuals who have previously engaged in sexual attacks fall under, based on actual statistical evidence, but at odds with the stereotypical suspect description. For example, the suspect was described as a male employed in a form of a skilled job, affectionate and acts maturely (see Marshall & Alison, 2007 for complete descriptions). Participants tested in groups were first required to read the case information individually, and afterwards they were asked to discuss the case between themselves in order to form a collective judgement.

### **2.2.5 Measures**

After being briefed and ensuring that all instructions were understood, the participants were asked to rate the extent to which the suspect could be considered guilty. In addition, they were required to rate their perceptions about the accuracy of the judgement (1= Not at all accurate, 2= very small accuracy, 3= slight accuracy, 4= some accuracy, 5 = fair level of accuracy, 6= fairly good accuracy, 7= good accuracy, 8= very good accurate, 9= almost completely accurate, 10= completely accurate) before and after being presented with the atypical profile. This process was necessary for measuring the extent of belief perseverance. In order to assess the level of cognitive resources that were expended during the decision making process, the participants were asked to rate their involvement level on a 10-point likert scale (1= none, 2= very small, 3= slight, 4= some, 5 = fair level, 6= fairly high, 7= high, 8= very high, 9= almost complete, 10=greatly), as well as how difficult it was to make the decision (1= not at all, 2= very low, 3= somehow low, 4= low, 5= neither difficult nor easy, 6= slightly, 7= moderately, 8= quite difficult, 9= very difficult, 10= extremely difficult). Prior to indicating their level of involvement, the participants were briefed that the involvement described the level of mental effort devoted towards understanding and

evaluating the case. Lastly, the participants were debriefed, and their participation in the experiment was appreciated.

## 2.3 Results

### 2.3.1 Manipulation Checks

A slightly higher level of involvement in the task was noted for participants tested at a circadian congruent time;  $M_{congruent} = 6.55$ ,  $SD = 2.36$  vs.  $M_{incongruent} = 5.88$ ,  $SD = 2.56$ . Similarly, participants tested at congruent times reported higher levels of difficulty in making judgements;  $M_{congruent} = 6.23$ ,  $SD = 2.35$  vs.  $M_{incongruent} = 5.74$ ,  $SD = 2.21$ . Neither difference for level of involvement or difficulty reached statistical significance;  $t(62) = 1.08$ ,  $p = .14$ , one tailed, Cohen's  $d = 0.27$  for involvement, and  $t(62) = 0.87$ ,  $p = .19$ , one tailed, Cohen's  $d = 0.22$  for difficulty.

### 2.3.2 Guilt Judgements

Four key theoretical patterns were observed in the analysed data. First, the impact of time of judgement that reflected the extent to which the participants changed their guilt ratings after being briefed on the atypical profile. Second, the study obtained a pattern of interaction between the circadian congruence, and time taken to make guilt rating (see Fig. 1.1). The third pattern involved interaction between group and time (i.e. match vs. mismatch) of ratings (see Fig. 1.2); while the fourth involved the interaction between circadian match/congruence and group (see Fig. 1.3).

Data on guilt judgement was analysed with a 2 (circadian congruent vs. circadian-incongruent) x 2 (individual vs. group) x 2 (before vs. after the atypical profile presentation) mixed analysis of variance (ANOVA). From the analysis, there was no statistically significant difference for a time of testing (congruent or incongruent with circadian preferences),  $F < 1$ . Similarly, the main effect of testing condition (individually or in a small group) was not significant,  $F(1, 60) = 1.25$ . A significant difference was however noted for

effect of the time of judgement,  $M_{before} = 7.26$  ( $SD = 1.52$ ) vs.  $M_{after} = 5.44$  ( $SD = 2.07$ ),  $F(1, 60) = 47.23$ ,  $MSE = 2.35$ ,  $p < .001$ . Further, a significant interaction was noted between the circadian time of testing and the judgement time as illustrated in Figure 1.3:  $F(1, 60) = 4.65$ ,  $p = .04$ . The participants also made a significant downward revision of their guilt judgement after presentation with the atypical profile for both circadian congruent times,  $t(29) = 6.02$ ,  $p < .001$  and at circadian incongruent times,  $t(33) = 3.46$ ,  $p = .002$ . As anticipated, significantly less time taken to provide/make pre- and post-profile judgements were noted under circadian-incongruent times thus suggesting more robust belief perseverance,  $t(62) = -2.13$ ,  $p = .02$ , one tailed.

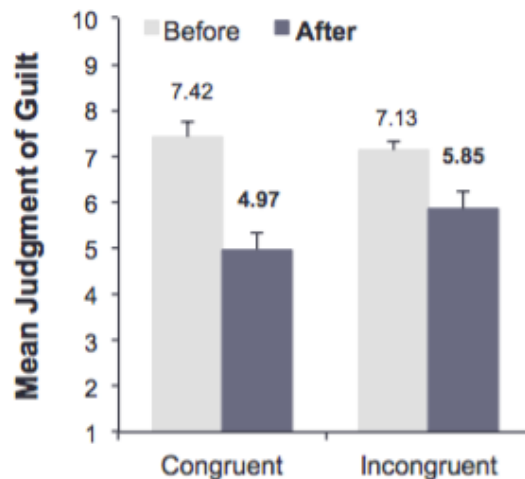


Figure 1.1: Mean judgement of suspect's guilt before and after provision with atypical profile based on circadian preferences (circadian /congruent times vs. circadian/incongruent times).

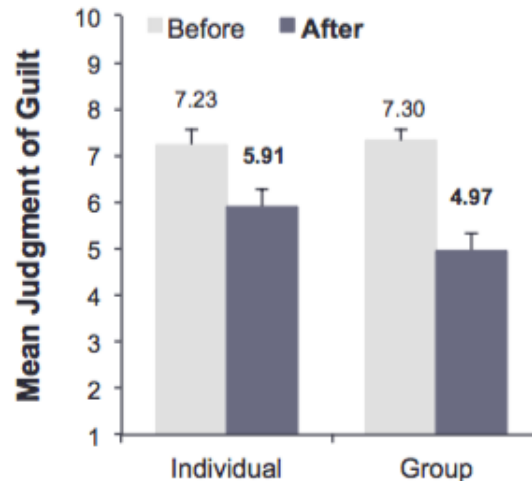


Figure 1.2: Mean judgement of suspect's guilt before and after provision with atypical profile based on individuals vs. group.

Further, the effect of individual or group as a test condition on guilt judgements collapsed across time of testing was controlled by circadian congruency,  $F(1, 60) = 4.50$ ,  $MSE = 3.89$ ,  $p = .04$  (see Fig. 1.3). Testing condition (individual vs. group) using unplanned post-hoc tests did not reveal a significant effect (with a Bonferroni-corrected  $\alpha$  set at .0125) on guilt judgements at circadian congruent time,  $t(28) = -.61$ . Individual guilt judgements were however significantly higher than group judgements when the participants were tested at circadian mismatching time,  $t(32) = 2.72$ ,  $p < 0.05$ . Based on these results, there are no significant differences of individual and group guilt judgements for circadian congruent times. However, the differences for the two testing conditions are significant for circadian incongruent times.

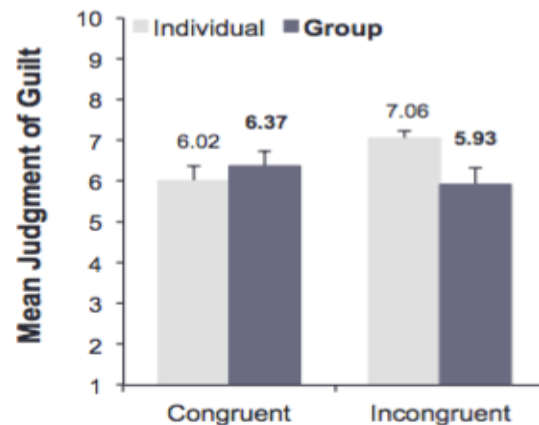


Figure 1.3: Mean judgement of suspect's guilt for individual vs. group based on circadian congruent and non-congruent times.

## 2.4 Discussion

The findings from the study affirm that circadian variations have a moderating effect on belief perseverance. Specifically, individuals tested at times that matched their circadian preferences exhibited less belief perseverance after being briefed with the atypical suspect profile. By contrast, participants who were tested at times that mismatched their circadian preferences were less flexible in terms of revising their beliefs after presentation with the suspect's profile. These findings thus corroborate earlier research which indicates that an individual's performance in tasks that require cognitive efficiency is dependent on the availability of cognitive resources (Natale et al., 2003; Schmidt et al., 2007).

The present experiment sought to investigate the extent of belief perseverance and alleviation from the context of circadian variations and belief perseverance. From the review of the literature, it was hypothesised that belief perseverance can be attributed to heuristic thinking, which is characterised by an exertion of less cognitive efforts in examining a situation and making judgements. To alleviate belief perseverance, it was argued that individuals should have access to greater cognitive resources that are required to engage in deliberative/cognitive thinking. In this experiment, augmentation of such resources was done



by testing individuals at their optimal circadian times, when their cognitive resources are at their peak level, as well as exposure to socially distributed thinking through participation in-group judgements. In order to test whether such augmentation had any significant impact in terms of alleviating belief perseverance, it was deemed important to test some participants individually and in groups during their non-optimal circadian incongruent times.

With regard to socially distributed thinking, one of the key findings from the study is that group participants exhibited less belief perseverance after presentation with the atypical suspect profile compared to individuals. In other words, it was easier for participants in a group to revise their initial judgements, compared to individuals making judgements on their own. This could suggest the concept of distributed cognition, which implies that interactions between several individuals allows for distribution of information processing and, thus, more deliberative thinking (Brown & Duguid, 1991; Olsson, Juslin, & Olsson, 2006). The study, however, proves that groups did not exhibit any significant differences in revising their initial beliefs when tested at congruent and incongruent times. This finding, in essence, suggests that even in non-optimal circadian times, members of a group were able to engage in more deliberative thinking due to augmentation of cognitive resources through distributed cognition.

The findings contributed to existing research on the effect of cognitive mechanisms on belief perseverance in several ways. First, the findings help prove that belief perseverance is not only a result of content of thought, for example, the availability of reasons for or against the initial belief (Anderson, 1982), but also the consequence of availability of cognitive resources, which determine the type of thinking to be applied (intuitive or analytical). The extent to which counterarguments are valid depends on the availability of cognitive resources. In the absence of cognitive resources, individuals are more likely to engage in less conscious/heuristic thinking that does not give adequate consideration to the issue at hand.

On the contrary, individuals provided with greater cognitive resources can engage in more analytical thinking and can, therefore, rely on counterarguments to revise their initial faulty beliefs. Empirically, the present study provides credible evidence that circadian variations and socially distributed thinking have a positive impact on belief perseverance alleviation, by providing more cognitive resources for tasks that demand higher levels of cognitive efficiency.

Another insightful finding from the present study, as aforementioned, is the observation that belief perseverance alleviation did not change significantly for group participants when tested at circadian congruent and incongruent times. It can thus be argued that group thinking allows for greater exploitation of individual cognitive resources, even at non-optimal times. Some studies such as List (2008) had however proven that, in some context, group thinking might lead to optimal results. This is likely to be the case when the groups are less structured. In the present study, this aspect was overcome by grouping individuals with similar circadian preferences in the same groups. In future, researchers may, therefore, investigate the impact that mixed group participants (i.e. morning and evening persons) have on the extent of alleviation of belief perseverance. For example, researchers can test whether inclusion of evening type persons in a group comprising mainly of morning type persons tested in the morning hours (circadian congruent times) can reduce the extent of belief perseverance alleviation.

From yet another perspective, the study suggests that, besides influencing the level cognitive resources available, circadian timing may influence other cognitive performance risks, such as distraction and attentiveness. The study, for instance, finds that during circadian congruent times, individuals spend more time in making a judgement, thus implying that they are more attentive and less distracted. It is also at circadian congruent timings that individuals are likely to consider the decision-making process as difficult, and, therefore, use more

cognitive resources. It has also been found that individuals who considered the judgement difficult are more likely to revise their beliefs after being provided with counter evidence. The availability of cognitive resources impacts on the level of understanding of counterevidence that is necessary to alleviate belief perseverance. In the real world decision-making such as courtrooms, the implication is that individuals required to perform tasks at their non-optimal times are at a competitive disadvantage compared to individuals operating in their optimal times. This is especially the case for tasks that require deeper reasoning. In such a case, the negative effects of cognitive stress, such as suboptimal decision-making, can, in part, be minimised by providing opportunities for individuals to work in groups.

The findings also have implications for past explanations of belief perseverance. In the present study, it has been suggested that instructions to consider counterarguments may successfully lead to a reduction of the initial belief by inviting deeper processing of the counterevidence. Such instructions may, however, fail when an individual's cognitive resources are depleted, for instance, by requiring the person to undertake a task that requires higher cognitive efficiency at a circadian incongruent time. Alternative accounts by studies such as Nestler (2010) have suggested that judgements are, to a large extent, mediated by metacognitive perceptions pertaining to difficulty in handling the task. Nestler (2010), in particular, suggested that individuals tend to reduce the likelihood of the truth or an outcome from the extent to which they find generating reasons for or against the outcome difficult. From the present study's findings, individuals examined at circadian congruent times tended to perceive the task as more difficult, but at the same time, exhibited less belief perseverance. Therefore, Nestler's (2010) metacognitive explanation is not supported by the study's results.

The study thus concludes that circadian preferences can have a significant impact on cognitive resources available for decision making in processes that require higher cognitive efficiency. During circadian incongruent times, individuals are predisposed by relying on

automatic/unconscious response systems, resulting in more pronounced belief perseverance. This ensures that individuals tested at the circadian congruent preferences, as well as allowing for distributed cognition through participation in-group thinking, can overcome this impact. In the case of the distributed cognition, it has been shown that the efficiency of group thinking is not affected by congruent or incongruent circadian timings. Therefore, socially distributed thinking has a positive impact on augmenting cognitive resources that influence the level of belief perseverance.

## **Chapter 3: The Effect of Circadian Variations and Type of Reason given on Belief**

### **Perseverance in a Legal Context**

#### **3.1 Chapter Introduction**

##### **3.1.1 Study Background**

Imagine you are a police officer in charge of an investigation. You are reading a suspect's description related to your case. You may form an opinion about this suspect's guilt or innocence. Now you receive an offender profile, which is at odds with the suspect's description you have just read. Two things could happen: you can change your mind, or you can stick to your own belief. People tend to hold onto their belief even when new evidence contradicts their initial beliefs. This phenomenon is known as belief perseverance (Ross et al., 1975). While different explanations have been proposed for this phenomenon (e.g., Anderson, 1983; Sanna, Schwarz, & Stocker, 2002), few studies have looked at the factors that may moderate the extent to which people will persevere with their original belief. In the present experiment, Author considers two factors: whether they provide a reason for the original belief or against it, and whether they are tested at their least compatible or most compatible circadian time.

##### **3.1.2 The Psychology of Belief Perseverance**

Belief perseverance, as reviewed in the introduction chapter, occurs when people who have learned about an event continue to stand with their opinion, even after they are told that it was fictitious. There have been efforts to research on the various ways in which belief perseverance can be alleviated. Anderson, Lepper, and Ross (1980) proposed that asking participants to provide an explanation that would go against their beliefs would diminish belief perseverance. In their experiment, half of the participants were given a scenario suggesting that people who are risk-takers make better fire-fighters compared to cautious people; the other half were told the opposite was true. Both groups were told to write down

possible explanations for the arguments in the scenarios they had read. The authors found that participants who had been told that risk takers make better firefighters were more likely to change their belief if they had explained why a cautious person might make a better firefighter. This suggests that generating causal explanations for an alternative theory will help alleviate the effect of belief perseverance (see also, Anderson & Sechler, 1986; Lord, Ross, & Lepper, 1979).

It is possible, however, that belief perseverance does not decrease because people simply generate an alternative explanation. It could be due to the fact that generating an alternative explanation is difficult, and demands deeper level of cognitive processing. For example, Sanna et al. (2002) hypothesised that it was difficult for people to list many reasons for an alternative outcome. They asked participants to read a story adapted from Fischhoff (1975), relating a battle in the British-Gurkha war. Half of the participants were in a “British win” condition, where they were told, “The British overcame the Gurkhas and ultimately won the war.” The other half of the participants were in a “Gurkha win” condition, where they were told, “The Gurkhas overcame the British and ultimately won the war.” Participants were then asked to list two or ten reasons for the victory of either the Gurkhas or the British. Specifically, participants in the British-win condition were required to list their thoughts supporting the Gurkha victory, whereas the participants in the Gurkha-win condition required listing their thoughts supporting a British victory. Sanna et al. (2002) found that the alternative outcome was deemed less likely to have occurred when participants had to list ten thoughts, compared to when participants had to list two thoughts only. These findings suggest that producing many reasons is much more difficult than listing only a few.

Nestler (2010) examined this possibility in two experiments while investigating belief perseverance. In the first experiment, participants were asked to read a scenario describing a psychological study looking at toy preferences in children. For example, when some

participants were told that when children were forbidden to play with a toy, their attitude towards this toy became more positive. After reading the brief, participants were split into three groups. The first group was asked to generate an explanation for the outcome reported. The second group was asked to list two possible reasons for the occurrence of this outcome, while a third group was asked to list ten possible reasons. Participants were then informed that the reported experiment had not been carried out. Rather, the report was invented to present the typical procedures of psychological experiments. Participants were then asked whether they believed the fictitious outcome that they had read about would be likely to be true.

Nestler (2010) hypothesised that, when people experience difficulties in explaining a given outcome, they might also believe that this outcome is less likely to be true. He found that participants who had listed only two reasons for the occurrence of the spurious study results were more likely to believe these results would actually be observed if the study were to be carried out, compared to participants who had been asked to list ten reasons for the occurrence of the same results. In a second experiment, Nestler (2010) reversed these patterns by asking participants to list either two or ten explanations for the occurrence of the opposite outcome. He found that providing two reasons for the opposite outcome reduced belief perseverance, however providing ten reasons for the opposite outcome led to a sharp increase in belief perseverance.

Nestler (2010) concluded that individuals used their subjective experience of difficulty in judging the likelihood of an outcome to evaluate this likelihood. Accordingly, the ease with which people could generate a few reasons for a given outcome increased belief perseverance in this outcome, while the ease with which people could generate a few reasons against the occurrence of a given outcome decreased belief perseverance. Besides experiencing ease or difficulty while generating reasons, there is another factor which has been shown to affect

belief perseverance; namely the cognitive resources available at the time of judgement. This work is reviewed in the next section.

### **3.1.3 Circadian Variations, Dual-Processes, and Belief Perseverance**

Villejoubert, Khan, and Vallée-Tourangeau (2013) investigated the influence of circadian preferences on belief perseverance in a legal context. They hypothesised that belief perseverance results from the operations of rapid and automatic cognitive processes, whereas belief revision results from slower and more deliberate and effortful cognitive processes (Kahneman, 2003; Sloman, 1996; Stanovich & West, 2000). Hence, when people are tested at their preferred circadian time, their increased cognitive resources should result in less belief perseverance. At incongruent circadian times, however, their limited cognitive resources should result in more belief perseverance. The researcher asked participants to read a description of a crime followed by a suspect description presenting a typical suspect and, finally, an offender profile describing an atypical offender. They were then asked to estimate the probability that the suspect was guilty once before reading the offender profile and once after reading the profile. Belief perseverance was measured as the difference between these two probability judgements. Half of the participants were tested at a time that was congruent with their circadian preferences (e.g., morning-types tested in the morning), while the remaining half were tested at an incongruent time (e.g., morning-types tested in the evening). Results showed that belief perseverance was the largest when individuals were tested at incongruent circadian times (compared to when they were tested at congruent times), suggesting that belief perseverance was more pronounced when people had limited cognitive resources at their disposal, as anticipated by the author. These results suggested another way to test Nestler's (2010) hypothesis. When people experience difficulty in explaining an outcome, it leads to weaker beliefs. Thus, the author managed to manipulate people's cognitive resources available through circadian preferences.



### 3.1.4 Present Experiment

The current research sought to establish whether belief perseverance occurs in decision-making and under what circumstances. Furthermore, the research sought to understand whether individuals tested at congruent times would exhibit less belief perseverance than those tested at incongruent times. Moreover, it sought to examine whether individuals providing reasons for the alternative outcome would exhibit less belief perseverance than those providing reasons for the original outcome. Under circadian incongruent testing, the author expected that individuals would have less cognitive resources available, concluding that generating reasons supporting the original belief would be more difficult. When it is difficult to generate reasons in favour of a known outcome, individuals should rethink their initial judgement and change their mind. Therefore, it was expected less belief perseverance, not more, under incongruent thinking when participants are asked to provide reasons for the outcome (hypothesis 1, replicating the condition where participants had to provide 10 reasons for the outcome in Nestler 2010, Experiment 1). Under circadian congruent testing, by contrast, it could be assumed it was easier to generate reason supporting the original belief, so it can be expected that an increase in belief perseverance under congruent thinking when asked to provide reasons for (hypothesis 2, replicating the condition where participants had to provide 2 reasons for in Nestler, 2010, Experiment 1).

For reasons against, the pattern should be different. Generating reasons against is hard, and under incongruent testing, it would be hardest, so it was expected for participants to revert to their original belief and show more belief perseverance (hypothesis 3, replicating the condition where participants had to provide 10 reasons against in Nestler, 2010, Experiment 2). Whereas under congruent testing, generating reasons against should be easier (they have more cognitive resources to do so), therefore, this should lead to a decrease in belief

perseverance (hypothesis 4, replicating the condition where participants had to provide 2 reasons against in Nestler, 2010, Experiment 2).

## **3.2 Method**

### **3.2.1 Data Management**

The scores obtained from the experiment followed a normal distribution in which the value of multivariate kurtosis was less than the recommended 1.96. The sample from Kingston University students was obtained from a population that follows a probability distribution. As such, it was considered necessary to make use of parametric statistical tests including *t*-test and ANOVA.

### **3.2.2 Participants and Design**

A total number of 162 Kingston University students took part in the study (Mean age = 22 years, *SD* = 6.84). Some participants were compensated with psychology course credits, while others were volunteer university students. Participants who were familiar with the task were removed from the study (*n*=4). The experiment used a 2 × 2 between-subject design. The independent variables were the time of testing (circadian-congruent or circadian-incongruent) and the type of reasons given (for suspect's guilt or against suspect's guilt). Judgements of the probability of guilt, level of confidence in the guilt judgements, involvement with the case and difficulty in forming a judgement about the suspect's guilt, as well as the difficulty of generating reasons, were measured as dependent variables.

### **3.2.3 Materials and Procedure**

The nature of the experiment was explained to participants, and informed consent was sought. In order to determine their circadian rhythm preference, participants were first asked to complete the abridged English Version of the Morningness-Eveningness Questionnaire (rH&O, Chelminski et al., 2000). MEQ consists of 5 items to assess the time of day an

individual feels the most alert (see Appendix B<sub>2</sub>). MEQ validation was conducted by Chelminski et al. (2000) they suggested internal consistency (Cronbach  $\alpha$ ) MEQ was 0.70.

Participants' responses to each of the items were added up and ranged from 4 to 25. According to the scoring criterion, participants can be classified as 'definitely evening types' (4-7), 'moderately evening type' (8-11), 'neither type' (12-17), 'moderately morning type' (18-21), and 'definitely morning types' (20–25). High scores indicate a greater degree of morningness, while low scores indicate a greater degree of eveningness. Participants who were classified as 'neither' type were excluded from the rest of the study ( $n= 11$ ).

After their circadian preference was identified, participants were invited to take part in the second part of the study, and were randomly allocated to one of two conditions: half of the participants were tested at a time that was congruent with their circadian preferences ( $n=81$ ) while the remaining half of the participants was tested at an incongruent time ( $n=81$ ). Specifically, circadian congruent testing involved either testing individuals with a morning circadian preference (hereafter M-types) before 12noon, or testing individuals with an evening circadian preference (hereafter E-types) after 12noon. Conversely, circadian incongruent testing involved either testing M-types after 12noon or E-types before 12noon.

In this second part of the experiment, participants were invited to complete a short questionnaire on investigative decision-making, which was introduced as involving a series of sexual assaults against girls. Participants were reminded that should this material cause them discomfort or distress, they were not obliged to respond to the questionnaire and could leave the questionnaire at any time. Prior to the start of study, participants were further informed that they were not under any time pressure into giving an answer and had as much time as they liked to read and answer each task. Upon consenting to participate, individuals were asked to record their MEQ score and to rate the extent to which they felt mentally alert on a visual analogue scale ranging from 1 to 10 (1 = not at all, 2= very low, 3= somehow

low, 4= low, 5= neither low or high, 6= slightly alert, 7= moderately, alert 8= quite alert, 9= very alert, 10= extremely alert).

They were then asked to imagine they were acting as the Senior Investigating Officer in charge of investigating a series of sexual assaults against young girls, and were invited to read a laminate sheet providing information about the incident. The information presented was adapted from Marshall and Alison (2007), and included some background information, a short description of the suspect, and a description of the offence (see Appendix B<sub>1</sub>). The sheet then informed participants that an individual had been brought to their attention following a media broadcast of the suspect description. The following detailed description of this individual was then presented to them:

Suspect A is a 44 year old white male who is 6ft 2 inches tall, has dark blonde hair and has a tattoo on his left arm. Further inquiries have revealed that he is currently single and he is described by local people as insecure with women, although, he has had one previous relationship with a woman which lasted 6 months. He lives alone in an apartment complex half a mile from where the crimes took place and he grew up in the local area, which is reflected, in his accent. He is currently unemployed and inquiries in local pubs revealed that he is a fairly heavy user of alcohol. He was brought up in a poor, working class family and he dropped out of school at 15 before taking his O-levels. Local people described him as having a short temper and a tendency to be quite aggressive. A search of his home revealed that he had a large collection of pornography.

After participants read this information, they were asked to consider the case and decide whether they thought the suspect was the offender. Specifically, they were asked to rate the probability that the suspect may have committed the series of the offences based on the available information. Participants were asked to report their answer on a visual-analogue

scale ranging from 1 to 10 (1 = impossible, 10 = Certain). Next, participants were asked to rate the degree to which they felt confident that their judgement was correct on a visual-analogue scale ranging from 1 to 10 (1 = Not at all confident, 10 = Absolutely confident). After this, half of the participants were asked to provide five reasons explaining why the suspect may actually be the offender (for suspect's guilt condition), or to provide five reasons explaining why the suspect may not actually be the offender (against suspect's guilt condition).

Next, participants were told that, due to the serious nature of the offence, a behavioural investigator was requested to assist them in their apprehension of the unknown offender and produced the following offender profile:

In most crimes of this nature the offender is employed in some form of skilled or office job. The offender will usually be married, often with children of his own. The offender will be sexually exploratory and will probably have had several sexual partners. The offender will own a pornography collection. Most offenders live within 2 miles of the scene of the crime. Many offences of this type do not involve the use of alcohol or drugs. Offenders of this sort are often perceived by others as being quiet, self-assured individuals. Sex offenders of this nature try to avoid police attention and usually have no previous criminal convictions. Offenders typically appear to have normal moral and belief structures. Offences like this are characteristically committed by individuals of approximately 25 years of age (average). Most are aged under 30. This type of sex offender often has a superficial charm, and will probably be fairly popular. The offender will probably have been educated beyond the age of 16 and is likely to have gone to university.

After they finished reading the profile information, participants were asked again to rate the probability that suspect may have committed this series of offences (this time, based on

all the information at their disposal), as well as to provide a second confidence judgement. Participants were then asked to rate their level of involvement in the case (1 = not at all, 10 = extremely) and the extent to which they found it difficult to list reasons as well as to estimate the probability that the suspect might have been the offender (1 = not at all, 10 = very). Next, they reported their gender, age, area and level of study. Finally, all participants were thanked and debriefed by the researcher.

### 3.4 Results

To compute the time of testing (circadian-congruent vs. circadian-incongruent) variable, it was classified testing times as “morning-congruent” if testing took place before 12:00 and “evening-congruent” if testing took place after 12:00<sup>2</sup>. The participants were then split up as “morning-type” or M-type and “evening-type” or E-type, depending on whether their MEQ score was above or below the median score for the entire sample,  $Mdn = 14$ . As expected, the MEQ scores for E-types were significantly lower than the MEQ scores for M-types,  $M_{E-type} = 10.14$ ,  $SD = 1.96$  vs.  $M_{M-type} = 17.93$ ,  $SD = 2.76$ ,  $t(160) = 20.56$ ,  $p < .001$ . M-types tested after 12.00noon and E-types tested before 12.00noon were in the circadian-incongruent condition ( $n = 40$ ) whereas M-types tested before 12.00noon and E-types tested after 12.00noon were in the circadian-congruent condition ( $n = 53$ ).

#### 3.4.1 Manipulation Check for Circadian Congruency

To ensure that the circadian congruency of the time of testing had an impact on cognitive processing, a Multivariate Analysis of Variance (MANOVA) was conducted with time of testing (circadian-congruent vs. circadian-incongruent) as an independent variable and mental alertness, involvement with the case, difficulty to provide reasons for or against the suspect’s guilt, difficulty in judging the likelihood of the suspect’s guilt, and finally the number of

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<sup>2</sup>Adan and Almira’s (1991) classified testing times as “morning-congruent” if testing took place between 07:00 and 15:00 and “evening-congruent” if testing took place after 15:00 and before 07:00. Their study, however, used night shift workers. Since this study involved students, it was decided to use 12:00 as a cut-off point.

reasons generated as dependent variables. Figure 2.1 presents the mean data for each measure. Unfortunately, results revealed no statistically significant difference in cognitive processing based on testing time congruency with circadian preferences,  $F(5, 156) = 0.43, p = .82$ ; Wilks'  $\Lambda = 0.98, \eta_p^2 = .014$ .

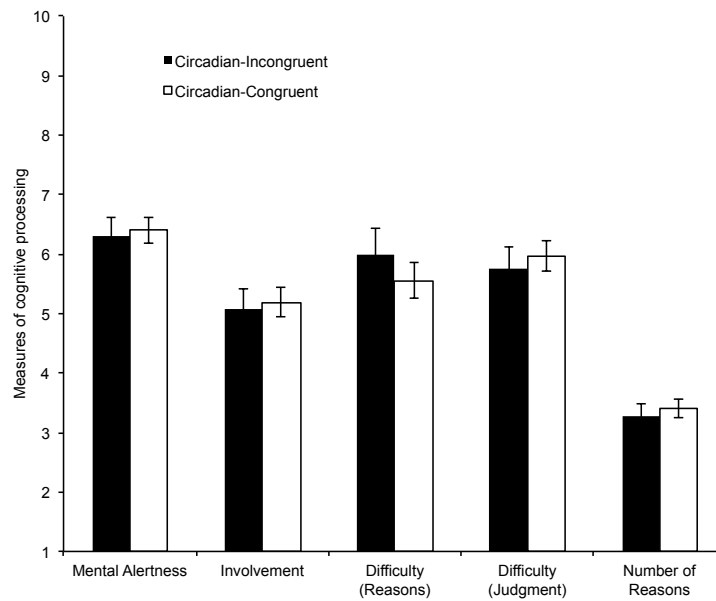


Figure 2.1: Measures of cognitive processing as a function of circadian congruency at the time of testing. Error bars represent standard errors.

### 3.4.2 Probability of Guilt Judgements

The theoretically important patterns in these data are the effect of time of testing (circadian-congruent or circadian-incongruent) and the type of reasons given (for suspect's guilt or against suspect's guilt) on people's persistence in their original judgement of the probability that the suspect committed the offence after being presented by an atypical offender profile. The degree of belief persistence after the profile presentation was computed as follows: first, the absolute difference between the first and second guilt probability judgements was computed. Since those judgements were made on a scale ranging from 1 to 10, the absolute difference ranged from 0 (no change) to 9 (maximum change). The absolute difference score to obtain a belief persistence score ranging from 0 (no belief persistence) to

9 (absolute belief persistence) was reverse coded. A 2 (time of congruency)  $\times$  2 (type of reasons given) between-subject Analysis of Variance (ANOVA) was conducted on the belief persistence scores.

Time of testing did not affect belief persistence,  $M_{\text{congruent}} = 7.31$ ,  $SD = 1.78$ ,  $M_{\text{incongruent}} = 7.06$ ,  $SD = 1.55$ ,  $F < 1$ . Similarly, the type of reason given (for vs. against the suspect's guilt) did not affect belief persistence,  $M_{\text{for}} = 7.33$ ,  $SD = 1.54$ ,  $M_{\text{against}} = 7.04$ ,  $SD = 1.79$ ,  $F < 1$ . Similarly, the interaction between time of testing and type of reasons was not significant,  $F(1, 158) = .42$ ,  $p = .51$ . For the sake of illustration, Figure 2.2 presents the mean belief persistence scores as a function of both testing time and reason type.

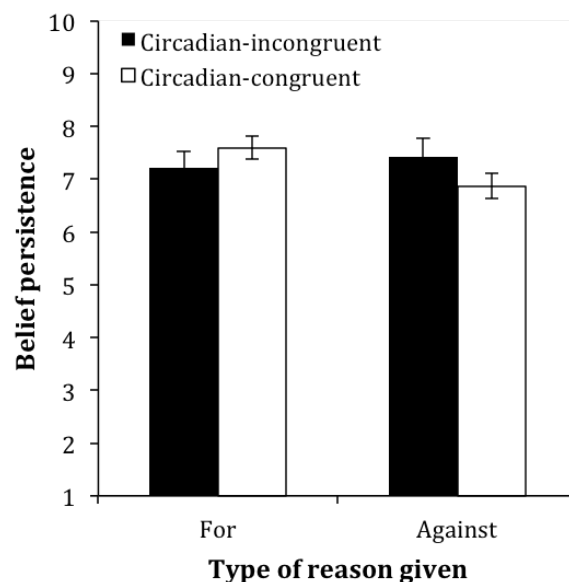


Figure 2.2: Belief persistence as a function of the congruence between circadian preferences and time of testing and as a function of the type of reasons given.

### 3.4.3 Change in Confidence Judgements

Finally, a 2 (time of testing)  $\times$  2 (type of reasons given) between-subject Analysis of Variance (ANOVA) was conducted on the change in confidence scores. Time of testing did affect confidence level,  $M_{\text{congruent}} = -0.28$ ,  $SD = 2.03$ ,  $M_{\text{incongruent}} = 0.32$ ,  $SD = 1.76$ ,  $F(1, 158) = 4.11$ ,  $p = .04$ . Similarly, the type of reason given (for vs. against the suspect's guilt) did



show a marginal effect on confidence level,  $M_{\text{for}} = 0.29$ ,  $SD = 1.98$ ,  $M_{\text{against}} = -0.26$ ,  $SD = 1.82$ ,  $F(1, 158) = 3.49$ ,  $p = .06$ . However, the interaction between time of testing and type of reasons was not significant,  $F(1, 158) = .35$ ,  $p = .55$ .

### 3.5 Discussion

This study sought to examine the cognitive processes that underpin belief perseverance with a specific focus on the effect of circadian variations and type of reason given for such perseverance. Study 1 and 2 used the same brief of a criminal case that entails a series of sexual assaults of young girls. The information was adapted from Marshall and Alison (2007). However, different outcomes were observed in relation to belief perseverance in circadian congruent and circadian incongruent times. Specifically, after being presented with the atypical suspect, study 1 indicated that participants tested at their circadian congruent times exhibited less belief perseverance compared to participants tested at their circadian incongruent times. In contrast to study 2, the participants did not significantly revise their guilt judgement after presentation with the atypical profile.

The contradictory results of study 1 and study 2 could be attributed to the differences in sample population. Study 1 comprised of staff members as well as students, while study 2 comprised of only students. It could be argued that, when given a uniform and well-balanced sample size, there would be little to no contradictory findings between the two studies. There was no correlation found between the age and gender on the findings of the two studies. This lack of correlation could be explained largely due to the sample population. There was no correlation found between age on belief perseverance ( $r = 0.85$ ,  $p > 0.05$ ) and gender on belief perseverance ( $r = 0.88$ ,  $p > 0.05$ ). Furthermore, a multiple regression analysis was used to test if the gender or age had any effect on the belief perseverance. The results indicated that neither age ( $R^2 = 0.007$ ,  $\beta = 0.85$ ,  $p > 0.05$ ) nor gender ( $R^2 = 0.008$ ,  $\beta = 0.88$ ,  $p > 0.05$ ) had any influence on the belief perseverance.

In study 1, the correlation of age on belief perseverance and gender on belief perseverance showed results similar to study 2. Age ( $r = 0.75, p > 0.05$ ) and gender ( $r = 0.80, p > 0.05$ ) had no influence on the belief perseverance. The multiple regression test conducted also revealed that neither gender ( $R^2 = 0.006, \beta = 0.86, p > 0.05$ ) nor age ( $R^2 = 0.007, \beta = 0.83, p > 0.05$ ) had any influence on the belief perseverance. The fact that students follow a morning-schedule regardless of their Morningness-Eveningness preference from a young age could have resulted in them being trained to function at their optimal level during the day. This is in line with an observation made by Roberts and Kyllonen (1999), who claimed that students are “atypical”. Therefore, it can be inferred that the *student nature* of the participants led to a difference between the results of the two studies.

Furthermore, contrary to study 1 and study 2 findings, Schmidt, Peigneux, and Cajochen (2012) have indicated that age could dampen or enhance the effects of circadian variations. In greater detail, the authors noted that age could cause changes in circadian and homeostatic processes, which, in turn, impact on cerebral activity. The fact that circadian variations were not affected by gender differences contradicts Boivin, Shechter, Boudreau, Begum, and Ying-Kin’s (2016) study. This study noted that, during the night (i.e., circadian incongruent times), women are characterised by significantly lower levels of alertness compared to their male counterparts. This suggests that, in turn, male participants are likely to be less susceptible to effects of circadian variations on cognitive efficiency compared to their female counterparts.

Another reason for this difference can be explained by taking into account the general intelligence and emotional intelligence levels of the participants. While some evidence is found that evening types showed higher intelligence (Roberts & Kyllonen, 1999), the difference in the sample population based on their Morningness-Eveningness preference in this study was statistically non significant. Lam and Kirby (2002) studied the effect of emotional and general intelligence on cognitive-based performance, and found that higher

rates of emotional and general intelligence correlated to higher cognitive-based performance. While intelligence, either general or emotional, was not tested in this study, it could have led to the differences in the study results. It is a possibility that there was a higher general or emotional intelligence present in study 1, compared to study 2.

While the results of this study are important, future research can establish a larger sample size and apply the experiment to a wider range of sample population. As suggested by Fritz and MacKinnon (2007), a sample size of 405 or greater is important to detect errors and generate a substantial statistical power. The experiment can be conducted by applying variables such as emotional intelligence and general intelligence level, and the M-E Type preferences. While study 1 and study 2 found no correlation of age or gender on the results, a larger sample size could be used to test the findings of this study.

Goel, Basner, Rao, and Dinges (2013) also acknowledged that circadian variations have the capability of degrading neuro-behavioural functions such as attention, cognitive speed and memory. They, however, emphasise that genetic components could also affect an individual's degree of stability in neuro-behavioural responses. Therefore, among some individuals with certain genetic makeup, circadian variations may not have an overly high impact on cognitive efficiency that is required to process information which influences belief perseverance. This aspect could, therefore, possibly explain the differences in findings between the two studies.

The finding showed that type of reasons (for and against) did not affect belief perseverance among participants in study 2, which largely contradicts other findings. Such as research by Schwarz (2004), for example, which suggested that individuals tend to experience difficulty while making their judgement. As a result, it is expected that individuals who experience these difficulties in generating reasons are likely to be characterised by possessing less belief perseverance, compared to individuals who find it easier to generate

reasons in support of their chosen outcome. Nestler (2010) expressed similar views, in which case, accessibility experiences (i.e. ability to generate supportive or counter-arguments) were found to influence the extent of belief perseverance persistence. Further, Anderson (1982, 2007) argued that belief perseverance emerges from the content of thought, such as the availability of reasons for or against a target belief or counter-explanation.

The present study's contradiction of the above views may be explained from the perspective of confirmation bias. Such bias as Grcic's (2009) example is evident which states that an individual engages in the habit of looking for information that supports, as opposed to challenges, one's belief system and preconceptions. In relation to the present research, the participants could, therefore, have held entrenched views regarding a sexual offender profile. It thus becomes possible to easily offer many reasons for or against a certain belief. When individuals are characterised by such confirmation bias, it is unlikely that they will be willing to easily admit the presence of erroneous beliefs, or be willing to change a belief after being provided with counterevidence. Several studies (Nyhan & Reifler, 2010; Howell & West, 2009; Cobb, Nyhan, & Reifler, 2013) also found that provision of information intended to correct misconceptions may fail to change the individual's prior opinions/beliefs.

From another perspective, the finding that circadian variations did not have a significant impact on mental alertness and task involvement contradicts other studies that reported significant findings. Valdez et al. (2012), for example, reported that mental performance or alertness tend to vary based on circadian variations, such that individuals are expected to be more alert at their circadian congruent times. The non-significant results, however, supported by research indicating that effects of circadian variations on mental performance could be affected by a range of other factors, such as the ambient conditions of the individual that is undertaking the task, the effects of practice and the nature of the task under consideration among others (Carrier & Monk, 2000). Moreover, Ferreira, Garcia-Marques, Sherman, and

Sherman (2006) and Posner and Snyder (1975) found that certain decision domains might be less susceptible to temporal variations in cognition. This is particularly the case for decision-making situations that require less controlled thought processes. In other words, some decisions may be dominated by the presence of automatic response mechanisms, as opposed to the need for more conscious deliberation.

A cognitive schematic theoretical approach also provides plausible explanations for the lack of change in confidence of judgement of the suspect's guilt level among participants based on circadian preferences. The theory suggests that individuals routinely persist in disconfirmed beliefs because they tend to generate explanatory schema that, once developed, becomes independent of the information that originally gave rise to them (Smith, 2009). In such cases, belief persistence can only be reliably alleviated through generating messages that offer alternative explanatory scripts. Alternatively, belief perseverance, in such a context, can be achieved by distracting the individuals under consideration from developing supportive schemata for the faulty belief (Smith, 2009). This is in contrast to varying of cognitive resources through circadian rhythms, as investigated in the present experiment.

To focus on the legal context in study 2, the non-significant results on the relationship between circadian variations, belief perseverance and type of reason given (for or against) have several implications. First, it suggests that scheduling demands which require a legal personnel to work or make decisions at various times of the day may not necessarily affect performance. In greater detail, individuals in courtrooms, who are required to make decisions at their circadian incongruent times, may not be more susceptible to inaccurate judgements and unnecessary belief perseverance, compared to their colleagues required to work at their circadian congruent times. However, other work sectors, such as the field of healthcare, have been found to be characterised significant differences in productivity of workers based on circadian variations. For example, McMenemy (2007) found that shift workers, such as

healthcare support staff and protective services employees who are required to work at their non-optimal circadian times, exhibit lower performance reports due to the presence of depleted cognitive resources (McMenamin, 2007).

The study also argues that the absence of differences in belief perseverance among individuals tested at congruent and incongruent times can be attributed to under or overestimation of the efforts required in alleviating a prior false or inaccurate belief. Legally, the implication is that biased judgements in criminal or civil cases may be given when the jury is not keen on the effects of belief perseverance. Bias may be induced by false positive information about the suspect that will tend to be exaggerated since individuals tend to find it more difficult to recall positive information (Gilovich, 1991). In addition, positive information has been shown to be less influential than negative information (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). If courtroom officials such as judges and prosecutors are not aware of such asymmetry, they are likely to be affected by belief perseverance while making decisions.

In conclusion, this study examined whether belief perseverance in a legal context is affected by circadian variations and type of reasons offered in a judgement. In contrast to the earlier findings in study 1, the results indicate that circadian variations have no influence on belief perseverance. Similarly, types of reasons offered in judgement were not found to have an effect on belief perseverance. The study attributes the differences in outcomes of the two studies to a variety of factors that were not taken into account in the experiments, but could potentially influence the cognitive efficiency of the participants. These include a larger sample size in age, gender, and genetic makeup, as well as the ability of individuals to adapt to external demands by tuning their circadian preferences. Furthermore, future research may benefit from applying variables such as emotional intelligence and general intelligence level with their circadian preferences.

## **Chapter 4: The Effect of Circadian Variations and Framing Effects on the Three Framing Problems**

### **4.1 Chapter Introduction**

#### **4.1.1 Research Background**

Valence framing, wherein the frame describes the same information based on Positive or Negative terms, has been an area of key interest in the past few decades (Bizer, Larsen, & Petty, 2011; Cassotti et al., 2012). Tversky and Kahneman (1981) conducted the pioneering study on framing effects, concluding that decision-making under risk is sensitive to whether the situation is described in terms of gains or losses. The participants in the study expressed very different valuations for options that were identical from an objective standpoint but were described as either gains or losses. Specifically, when presented with the ‘Asian Disease Problem’, the majority of the participants chose treatment A that was framed in terms gain lives over treatment B that was framed in terms of losing lives. There was no difference in the actual outcomes in the gain and loss conditions, hence the conclusion that individuals are risk-averse in gain situations and risk-taking in loss situations (Mahoney et al., 2011).

Task designs in which there are risk-free and risky alternatives are commonly referred to as “risky-choice” and form the basis of the present study. Other forms of valence framing include goal framing and attribute framing (Levin et al., 1998). The underlying notion in risky-choice framing is that context has a heavy influence on how individuals evaluate information, in that *how* something is said often matters much more than *what* is said. Since the original work by Tversky and Kahneman (1981), subsequent studies have suggested the presence of mixed findings with regard to whether framing an alternative, in Positive versus Negative terms, has an influence on the response towards the alternative. Some studies have reported a benefit for the Positive frame (e.g., McElroy & Dowd, 2007; McElroy &

Dickinson, 2010) while others have found no significant frame effects (e.g. Peters & Levin, 2008).

Framing effects have been observed in a variety of real-life contexts. For example, the study by Zaller and Feldman (1992) found that Americans thought very differently about the advantages of oil drilling when the issue was framed in terms of the country's dependency on foreign sources of energy, rather than in terms of the economic costs of the country failing to develop new energy sources. Framing is also used in the political field to shape opinions under certain conditions. In the field of marketing, negative attribute frames have, in some contexts, shown to be more persuasive in generating sales than positive ones (Putrevu, 2010). Based on prior research in the field of framing effects, it is evident that risky choice framing has a reliable and powerful impact on individuals' decision-making in various fields. It is thus important to investigate and identify the factors that may influence individuals to be susceptible to framing effects.

#### **4.1.2 Framing Effects From a Cognitive Perspective**

A number of studies have attempted to explain framing effects from cognitive perspectives. Gigerenzer et al. (1991) attributed framing effects to the construction of a mental model of the decisional situation among individuals. More specifically, this approach suggests that an individual will make a decision based on a comparison of the data/information used to describe the current situation and the pre-existing cognitive representations that are activated from the long-term memory (LTM). Similarly, Olekalns and Smith (2005) developed a model in which framing effects were suggested to occur as a result of the alternatives embedded in a cognitive causal schema. In this model, the manner in which alternatives are presented to an individual activates congruent schema (i.e. similar pattern of thought) from the LTM, which, in turn, leads to selective processing of available information, and finally the making of a decision that is biased (Olekalns & Smith, 2005). In



a circadian context, it would thus be expected that, during circadian incongruent times, individuals are more predisposed to selective processing of available information and inadequately reasoned use of congruent schema from LTM. This can be attributed to the presence of fewer cognitive resources that in turn increase the likelihood of framing effects occurring.

Some studies also affirmed the presence of a relationship between cognitive bias and framing. The study by Nakamura (2016), for example, focuses on framing effects among adolescents, and reports that cognitive bias has an influence on framing. In the study, college students, who were characterised by moderate and high levels of rational thinking as opposed to experiential thinking, were shown to be more susceptible to the framing effect. Goal-directed tasks and work that requires carefully considered decisions are examples of tasks that require rational thinking, while a task such as impulse buying makes use of experiential thinking. An earlier study by Shiloh, Salton, and Sharabi (2002), however, suggested that rational thinking does not, on its own, significantly moderate the framing effect on the risky-choice situation. Rather, individuals characterised by complementary (high rational/high experiential) and poor (low rational/low experiential) thinking showed a framing effect (Shiloh et al., 2002).

From another perspective, introducing negative bias by framing a particular situation in negative terms has been suggested to reinforce framing effects, due to the higher sensitivity of the human cognitive systems to negatively framed information (Ito & Cacioppo, 2005; Fiske & Taylor, 2013). Lupfer et al. (2000) further add that, during the process of impression formation, an expectancy that confirms negative information tends to overrule the effect of disconfirming positive information. By way of example, information that signals danger or threat to an individual tends to outweigh information signalling hope. In an attempt to explain the rationale behind such occurrences, Miclea and Curseu (2003) found that participants were

willing to allocate personal as well as external resources (e.g. calculators, computers and checklists) in the process of addressing situations that were framed as dangerous, and thus, the perception of an impending threat. By contrast, the participants were more reluctant in allocating resources to understand a situation framed positively as an opportunity. The general implication, therefore, is that the human cognitive system operates in such a way that greater resources are mobilised in processing negatively framed information. Based on these arguments, it is expected that, during circadian congruent times, individuals have greater cognitive resources to analyse negatively framed situations, and hence a lower incidence of framing effects.

While taking into consideration the “life” and “death” situation in the Asian Disease problem, it has been argued that such an issue carries different emotional connotations (Cassotti et al., 2012). When presented with such information, individuals will form initial positive or negative reactions, which affect attitudes and behaviours. Therefore, a participant’s automatic affective response is likely to guide the decision-making process. While providing evidence for such effects, McElroy and Conrad (2009) found that the effects of framing, in most cases, arise from unconscious processing. Neurological research also provides support for the argument that automatic affective responses have an influence on decision-making in emotional situations. De Martino, Kumaran, Seymour, and Dolan (2006), in this context, found the presence of increased amygdala activity that is usually associated with the tendency of individuals to conform to framing effects which includes risk aversion in gain frames and risk-taking in loss frames. Adolphs (2006) also argued that since amygdala is usually vital in the detection of emotionally relevant information that can be obtained from contextual cues, it is possible that framing effects are an effective response. Since affective responses are made unconsciously, they require low cognitive

resources/mental process. In such a case it can thus be suggested that circadian variations do not have a significant influence on risky choice framing.

#### **4.1.3 Present Experiment**

In light of the mixed findings in extant research on the factors influencing framing, this study sought to examine whether framing effects are more likely to occur in decision-making as a function of the Morningness-Eveningness orientation of the participants. Previous research in this field has mainly focused on the role of frames on individuals' preferences and choices (Tversky & Kahneman, 1987; Nelson, Oxley, & Clawson, 1997; Puto, 1987). The present study went a step further by evaluating the influence of circadian variations as one of the factors that affect the availability of cognitive resources and consequently the ability to make comprehensive judgements in framed situations. Prior research in similar areas has demonstrated that participants tested at their circadian incongruent times exhibit more stereotyping (Bodenhausen, 1990) and also exhibit less careful thinking of persuasive arguments (Martin & Marrington, 2005). However, the potential moderating effect of circadian variations on risky-choice framing is yet to be extensively studied. Thus, the present study ascertained whether Morningness or Eveningness affected participants' susceptibility to framing effects. It used the original framing effect task that involves the Asian Disease Problem as part of the investigation. In line with the circadian variations literature, the present study hypothesises that H1a: Participants tested at circadian congruent times would be less susceptible to framing effects in the Asian Disease Problem. H1b: Participants tested at their circadian incongruent times would be more susceptible to framing effects in the Asian Disease Problem.

## 4.2 Method

### 4.2.1 Data Management

As part of the data management process, it was established that the dataset did not comprise of missing values and hence elimination of the risk of distorted results. In addition, the multivariate kurtosis analysis indicated that the dataset followed a normal distribution with a value less than the recommended 1.96. The population from which the sample was derived was also assumed to support a probability distribution and hence the use of parametric tests which include *t*-test and ANOVA.

### 4.2.2 Participants

A total of 163 participants who were undergraduate and postgraduate students from Kingston University took part in the study. The sample comprised of 63 males (38%) and 100 females (62%) with a mean age of 23, *SD*=5.09. In terms of study level, 124 students (76%) studied at the undergraduate level while 38 students (23%) studied at the post-graduate level. All participants took part in the study voluntarily.

### 4.2.3 Design

The study made use of a 2 x 2 (i.e. circadian congruent, circadian incongruent x gain frame, loss frame) within-subjects design to assess the impact of framing on risky choice. The dependent variable in the study was the participants' reported risk preference based on the type of frame (gain and loss) in which case participants were either inclined to the risk aversion choice (Treatment A/Program A) or risky choice (Treatment B/Program B). Using the Asian Disease Problem the gain frame was linked to statements indicating that a particular choice would lead to saving of lives. By contrast, the loss frame was linked to choices indicating that a certain number of lives would be lost. The independent variable was

the time of testing which was optimal or non-optimal (i.e. circadian congruent and circadian incongruent) in terms of morningness and eveningness.

#### 4.2.4 Procedure

Students from the Kingston University campus were invited to take part in a 15-minute in-person framing survey. Upon acceptance of the invitation and provision of informed consent, the participants were issued with a participant number and MEQ score after completing the Morningness-Eveningness Questionnaire. In order to determine their circadian rhythm preference, participants were first asked to complete the abridged English Version of the Morningness-Eveningness Questionnaire (rH&O, Chelminski et al., 2000). The MEQ consists of 5 items to assess the time of day an individual feels the most alert (see Appendix C<sub>2</sub>). MEQ validation was conducted by Chelminski et al. (2000) they suggested; internal consistency (Cronbach  $\alpha$ ) was 0.70.

Participants' responses to each of the items were added up and ranged from 4 to 25. According to the scoring criterion, participants can be classified as 'definitely evening types' (4-7), 'moderately evening type' (8-11), 'neither type' (12-17), 'moderately morning type' (18-21), and 'definitely morning types' (20-25). High scores indicate a greater degree of morningness, while low scores indicate a greater degree of eveningness. A total of 8 participants were in neither type category, and were therefore excluded from the experiment. The remaining participants were also required to indicate their current mental alertness based on a visual analogue scale ranging from 1 to 10 ("1" representing not at all mentally alert and "10" representing extremely mentally alert).

The participants were then randomly allocated to one of two testing conditions: a circadian time of testing, or a circadian incongruent time of testing. One half of the participants were tested at their optimal circadian time ( $n=81$ ) while the other half at their non-optimal circadian times ( $n=82$ ). In within-subject design, each participant was presented with both the

gain and loss-frame problems. The following framing problems were adopted from Mahoney et al. (2011) and dealt with life threatening human diseases: Asian disease problem, Lung cancer and HIV virus. The complete set of framing problems is provided in appendix C<sub>1</sub>.

### **(1) Classic Asian Disease**

Imagine the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs have been prepared to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

**Program A:** 200 people will be saved.

**Program B:** 1/3 probability that 600 people will be saved and 2/3 probability that no people will be saved.

### **(2) Lung Cancer**

The National Cancer Institute has two possible treatments for lung cancer, which could become standard treatments across the country. Assume that the exact scientific estimates of the consequences of the treatments are as follows:

**Treatment A:** Of every 1000 people who get lung cancer, 400 will be saved.

**Treatment B:** 2/5 chance that 1000 of every 1000 who get lung cancer will be saved and 3/5 chance that no people of every 1000 who get lung cancer will be saved.

### **(3) HIV Virus**

The United States is expecting the outbreak of a new strain of HIV virus which is expected to kill 2000 persons. Two alternative programs were developed to combat the disease. Assume that the exact scientific estimates of the consequences of the programs are as follows:

**Program A:** 800 people will be saved.

**Program B:** 2/5 probability that 2000 people will be saved and 3/5 probability that no people will be saved.

The probabilities and payoffs used in the problems were varied in the ranges specified by Kühberger (1998) and Kühberger, Schulte-Mecklenbeck, and Perner (1999). The participants' choice in the risky-choice decision tasks was measured on a 10-point scale with Program A on one side of the scale and Program B on the other extreme end.

Half of the study participants were given three gain-framed risky choice problems, a cognitive reflection test (CRT), and then the same three risky choice problems, but using a loss frame. The remaining participants were given the same test, except that they were given the three loss-framed risky choice problems first. After making a decision on each risky choice problem (i.e. Program A or B on the 10 point scale), the participant's recorded the risk preference ratings on a scale ranging from 1 (most risk-averse) to 10 (most risk-seeking). In addition, the confidence ratings of the decision made were measured on a visual-analogue scale ranging from 1 (not at all confident) to 10 (absolutely confident). In the final part of the questionnaire, the participants were required to indicate their task involvement and provide demographic details including the age, gender, area of study and level of study. All participants were thanked and debriefed for taking part in the study.

### 4.3 Measures

#### 4.3.1 Circadian Preferences

Circadian preferences among the participants were measured using the abridged English Version of the Morningness-Eveningness Questionnaire (rH&O, Chelminski et al., 2000). From the statistical analysis, M-type participants scored significantly higher on the Morningness-Eveningness Dimensions compared to their E-type counterparts:  $M_{M\text{-types}} = 16.46$ ,  $SD = 2.41$ , ( $n=82$ ) vs.  $M_{E\text{-types}} = 10.10$ ,  $SD = 3.02$ . In consistence with standards established in prior studies, one-half of the participants were tested at the circadian congruent

times, in which case, the M-type participants were tested between 10am and 12noon, while their E-type counterparts were tested between 1pm and 5pm. The remaining half of the participants were tested at their circadian incongruent times.

#### **4.3.2 Risk Preferences**

The participants' risk preferences towards the alternatives (i.e. Treatment A or Treatment B) were the basis of establishing the absence or presence of framing effects. The preferences were measured through a 10 point scale, in which "1" indicated a definite preference for Treatment A and "10" a definite preference for Treatment B. Participants whose numerical ratings were below the midpoint (i.e. 1-4) were considered to be characterised by a risk-averse preference, while participants who chose numerical ratings from 5 to 10 were considered to depict preference for risky alternative.

#### **4.3.3 Cognitive Reflection**

Cognitive reflection, as measured in the study, is defined as an individual's tendency to override a strongly impelling incorrect response by engaging in the further reflection that leads to the correct response (Lambie, 2014). CRT thus measures cognitive ability and overlaps with the concept of critical open-mindedness. The CRT was adopted from Frederick (2005) and consisted of three seemingly simple questions. The test measured the participants' inclination to involve System 1 or System 2 cognitive processes in the decision-making process. Participants who failed all questions or only got one correct answer were considered to engage in Systems 1 cognitive processes that are quick, unconscious and intuitive. In contrast, participants who got 2 or 3 correct answers were considered to be characterised by System 2 cognitive processes that are slow, conscious and reflective (Stanovich & West, 2008).



#### 4.3.4 Task Involvement

The participants' level of task involvement was assessed based on a visual-analogue scale ranging from (1= not at all involved and 10=extremely involved). Higher scores were interpreted to mean use of higher cognitive resources in completing the survey, while lower scores were indicative of lower mental efforts. A mean score of 6.49,  $SD= 1.91$  was obtained, thus suggesting moderate levels of task involvement.

### 4.4 Results

#### 4.4.1 Cognitive Reflection Test

From the cognitive reflection, a mean score of  $M=0.67$ ,  $SD=0.92$  was obtained. Over half of the participants (57%) incorrectly answering all questions, 26% had 1 correct answer, 10% had 2 correct answers, and 7% had 3 correct answers.

#### 4.4.2 Manipulation Check

A manipulation check of the study results indicates a slightly higher level of task involvement for the CRT task among participants tested at circadian congruent times at  $M=6.58$ ,  $SD=1.77$  compared to participants tested at circadian incongruent times at  $M=6.39$ ,  $SD=2.06$ . However, the differences between the confidence levels of the two groups of participants were not statistically significant,  $t(161) = -.64$ ,  $p=.53$  at 95% confidence interval.

With regard to confidence levels in the gain frame, higher scores were recorded in all the three scenarios for participants tested at circadian congruent time (Frame 1:  $M=7.08$ ,  $SD=2.08$ ; Frame 2:  $M=7.13$ ,  $SD=1.97$ ; Frame 3:  $M=7.04$ ,  $SD=2.09$ ) compared to participants tested that their circadian incongruent times (Frame 1:  $M=6.38$ ,  $SD=2.02$ ; Frame 2:  $M=6.52$ ,  $SD=2.37$ ; Frame 3:  $M= 6.58$ ,  $SD=2.34$ ). The differences in confidence levels were statistically significant only in Frame 1,  $t(161) = -2.18$ ,  $p=0.03$ . No statistically significant differences were found in Frame 2,  $t(161) = -1.80$ ,  $p=0.073$  and Frame 3,  $t(161) = -1.36$ ,  $p=0.17$  (See Appendix C<sub>1</sub>).

In the loss frame, higher confidence levels were only noted in Frame 3 for participants tested at circadian congruent times (Frame 3:  $M=7.19$ ,  $SD=1.99$ ) compared to participants tested at circadian incongruent times (Frame 3:  $M=6.73$ ,  $SD=2.07$ ). However, the differences in Frame 3 were not statistically significant  $t(161) = -1.43$ ,  $p=0.15$ . In Frame 1 and 2, lower confidence level scores were noted for participants tested at circadian congruent times (Frame 1:  $M=6.53$ ,  $SD=2.22$ ; Frame 2:  $M=6.84$ ,  $SD=2.01$ ) compared to participants tested at circadian incongruent times (Frame 1:  $M=6.94$ ,  $SD=1.98$ ; Frame 2:  $M=6.94$ ,  $SD=2.01$ ). No statistically significant differences were found in Frame 1,  $t(161) = 1.24$ ,  $p=.216$  and Frame 2,  $t(161) = .33$ ,  $p=0.74$  at the 95% confidence interval.

### **Gain Frame and Loss Frame analysis Order 1 (Positive/gain frame first) vs. Order 2 (Negative/ loss frame first)<sup>3</sup>**

As part of the preliminary analysis, the study looked at the risky choices as a function of the order and frame. A 3 (Gain Frame: Frame, 1, 2 and 3) x 2 (Order: 1 and 2) mixed Analysis of Variance (ANOVA) was conducted with the risk preference as the dependent variable. From the analysis, there were no statistically significant differences for order of the frame (i.e. Order 1 or 2), and the risk preferences among the participants for each of the scenarios in the gain frame. For Frame 1, the Order 1 (Positive/gain frame first) participants had a risk preference mean ( $M=4.74$ ,  $SD=2.99$ ) which was identical to Order 2 (negative/loss frame first) participants  $F(1, 161) = .03$ ,  $p=0.96$ . In relation to Frame 2, Order 1 participants had a slightly lower mean ( $M=4.80$ ,  $SD=2.84$ ) compared to Order 2 participants ( $M= 5.02$ ,  $SD= 2.92$ ) but at an insignificant level,  $p>0.05$ . Lastly, for Frame 3, the mean of risk preferences was slightly lower for Order 1 participants ( $M=5.01$ ,  $SD=5.15$ ) compared to Order 2 participants at an insignificant level,  $p>0.05$ .

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<sup>3</sup> The framing problems were adopted from Mahoney et al. (2011). The problems dealt with life threatening human diseases: Asian disease problem (Frame 1), lung cancer (Frame 2) and HIV virus (Frame 3). Half of the participants were given three gained-framed risky choice problems, a cognitive reflection test, and the same three risky choice problems, but using a loss frame (Order 1). The remainder of the participants were given the same tests, except that they were given the three loss-framed risky choice problems first (Order 2).

An analysis was also conducted to assess whether the risk preferences in the loss frame varied based on whether the participant was examined using Order 1 or Order 2. For Frame 1, participants in Order 1 had a slightly higher loss frame mean risk preference ( $M=5.26$ ,  $SD=2.71$ ) compared to participants in Order 2 ( $M=5.08$ ,  $SD = 2.79$ ),  $F<1$ . For Frame 2, participants in Order 1 had slightly lower mean risk preference ( $M=5.34$ ,  $SD=2.52$ ) compared to Order 2 participants ( $M=5.44$ ,  $SD=2.51$ ),  $F <1$ . Similarly for Frame 3, Order 1 participants had an identical mean risk preference ( $M=5.07$ ,  $SD=5.38$ ) relative to Order 2 participants ( $M=5.07$ ,  $SD=5.37$ ),  $F <1$ .

While taking into consideration the average risk preferences for gain and loss frames, participants tested through Order 1 had a lower mean risk preference ( $M=4.92$ ,  $SD=2.36$ ) compared to participants tested through Order 2 ( $M=5.26$ ,  $SD=2.01$ ). Despite Order 1 participants depicting preferences for risk aversion and Order 2 participants depicting risk-taking behaviour, the differences were not statistically significant,  $p>0.05$ . Figure 3.1 summarises the differences in risk preferences based on the average scores (i.e. the three scenarios combined) for both gain and loss frames.

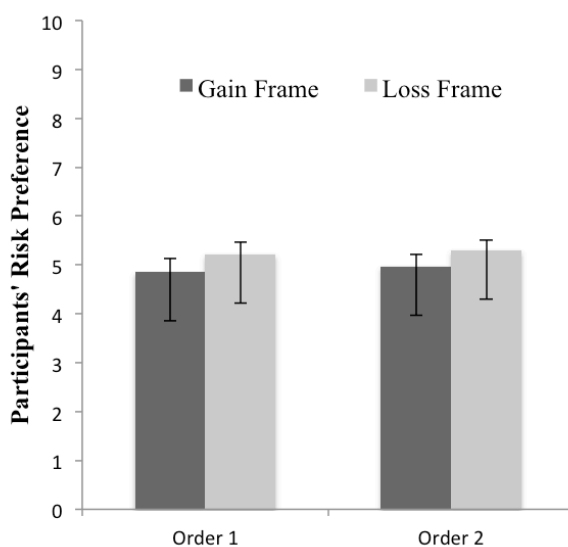


Figure 3.1: Participants' risk preferences based on Order of testing Order 1 (Positive/gain frame first) vs. Order 2 (Negative/ loss frame first).

#### 4.4.3 Circadian Preference

In order to test the primary circadian hypothesis, the data was examined to understand framing effects based on gain and loss frames in the context of circadian congruent and circadian incongruent time of testing. For the gain frame, participants tested at their circadian congruent time had a higher mean risk preference ( $M=5.77$ ,  $SD=2.38$ ) compared to participants tested at their incongruent times ( $M=4.03$ ,  $SD=2.0$ ). Based on ANOVA analysis, the differences were significant  $F(1,161)= 25.22$ ,  $p < .001$ . For the loss frame, participants tested at their circadian congruent time had lower mean risk preferences ( $M=5.09$ ,  $SD=1.91$ ) compared to participants tested at their incongruent times ( $M= 5.44$ ,  $SD=2.10$ ), although the differences were not statistically significant.

To further examine the influence of circadian preferences, the data was assessed for any significant revisions in the gain and loss frames for participants tested at their circadian congruent times and participants tested at their circadian incongruent times. Using the paired samples  $t$ -test the mean risk preference score ( $M=5.76$ ,  $SD=2.38$ ) for circadian congruent participants for the gain frame did not reveal any significant difference compared to the mean risk preference score ( $M=5.09$ ,  $SD=1.91$ ) for loss frame,  $t(82)=1.92$ ,  $p =.58$ . A frame effect was therefore absent with the majority of the participants, depicting neutrality in the choice of Treatment A or Treatment B/ Program A or Program B.

With regard to participants tested that their circadian incongruent times, the paired samples  $t$ -test revealed a significant difference in means for gain frames and loss frames. Specifically, the participants had a mean risk preference score of 4.03 ( $SD=2.01$ ) in the gain frame and a mean risk preference score of 5.44 ( $SD=2.10$ ) in the loss frame, which was significant,  $t(79)= -4.661$ ,  $p <.001$  (see Figure 3.2). Framing effects were therefore evident when participants were tested at their circadian incongruent times.

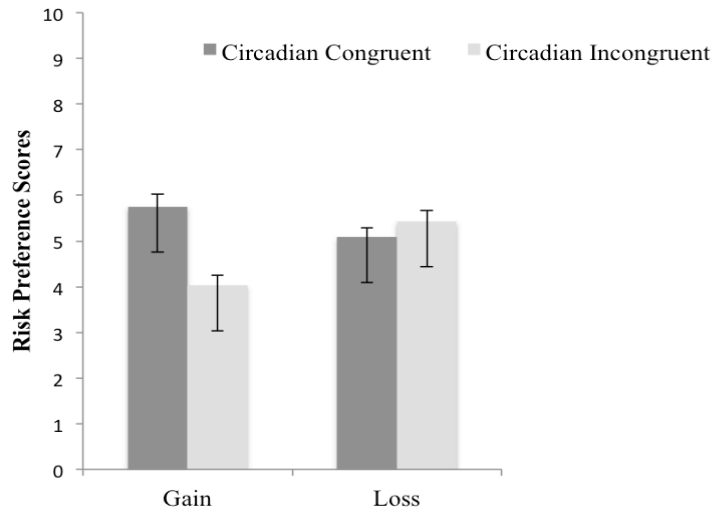


Figure 3.2: Differences in risk preference scores based on circadian preferences.

While taking into consideration demographic variables and risk preferences, no significant correlations were observed for age, gender and study level. However, a significant correlation ( $r = 1.55, p < .01$ ) was established between CRT and mean risk preference for the gain frame.

Table 3.1: Correlations between demographic variables and risk choices.

	Gender	Age	Study level	CRT	Task involvement	Mean Risk Gain	Mean Risk Loss
Gender	1						
Age	-.041	1					
Study level	.009	.636**	1				
CRT	-.122	.173*	.066	1			
Task involvement	-.080	-.079	-.058	.131	1		
Mean Risk Gain	.027	.041	-.043	.155*	.088	1	
Mean Risk Loss	.022	-.015	.009	-.073	.082	-.021	1

\*. Correlation is significant at the .05 level (2-tailed).

#### 4.5 Discussion

From the study findings, no significant changes were found in participants' risky choice preferences for the Asian Disease Problem, Lung Cancer and HIV virus based on the order in which the frames were introduced. Participants who were first exposed to the gain frame depicted an inclination towards neutrality in terms of the choice of Treatment A or Treatment B, and Program A or Program B. A similar inclination was observed among participants who were first introduced to a loss frame and later to gain frame. This finding suggests that framing effects may not be affected by the order in which the frames (gain and loss) are presented. In other words, there are no significant interactions between order and frame. Martinussen (2016) also made similar findings.

In relation to task involvement, participants tested at their circadian congruent times depicted slightly higher involvement for the cognitive reflection task compared to their counterparts tested at circadian incongruent times. The study's findings affirm previous research, which suggests that individuals operating at their circadian congruent times have greater cognitive resources, and are therefore more attentive and able to engage in deliberative thinking (Valdez et al., 2012; Bodenhausen, 1990). However, scores from the cognitive reflection test were not found to have a significant impact on the mean risk preference scores for both the gain and loss frames. In part, this can be attributed to the overall low scores that were obtained for CRT across the study's sample. Prior research by Peters and Levin (2008) also indicate that while individuals with higher critical thinking and numeracy tend to be less vulnerable to framing effects, the differences are not always significant. As such, it is expected that individuals with more reflective skills may be susceptible to framing effects in a similar way to their less reflective counterparts.

While taking into consideration the study's main hypothesis, the findings confirm that framing effects are less likely to occur when individuals are tested at their circadian

congruent times compared to circadian incongruent times. For example, the study's participants who were tested at their circadian congruent times were neutral in their choice of Treatment A or Treatment B, and Program A or Program B in both the gain and loss frames. By contrast, participants tested at circadian incongruent times were inclined to the risk-averse Treatment A/Program A in the gain frame, and more inclined to the risky Treatment B/Program B in the loss frame. While taking into consideration framing effects as a preference shift, the differences were significant, thus indicating the presence framing effects. Such framing effects were consistent with prior studies, indicating that individuals tend to be risk averse in gain situations and risk seeking in negative situations (Tversky & Kahneman, 1981; Mahoney et al., 2011; Bizer et al., 2011).

The presence of framing effects among individuals tested at circadian incongruent times further indicates individuals tested at their less optimal times have lower involvement when making decisions. This confirms earlier views by McElroy and Conrad (2009), indicating that framing effects mainly arise from unconscious processing of information. At circadian incongruent times, individuals have lower cognitive effects, and hence likely to engage in less conscious thinking that demands lower mental effort (De Martino et al., 2006; Martin & Marrington, 2005).

Some contradictory evidence on framing effects was also evident in the present study. In the gain frame, individuals tested at their circadian congruent time depicted neutrality in the choice of Treatment A or B at a mean of  $M=5.77$ , while circadian incongruent individuals in the same gain frame depicted an inclination towards risk aversion (Treatment A) at a mean of  $M=4.03$ . These findings may, in essence, suggest the presence of other factors that may override circadian variation effects, which were not included in the study. Such factors, as suggested by other studies, include the level of emotional arousal, effective levels and level

of motivation among others (Nabi, 2003; Gross, 2008; Martinussen, 2016). Future studies can include the influence of these variables in a circadian congruent/incongruent context.

In terms of contributions and implications, the findings of the present study helps highlight that performance in tasks requiring higher cognitive effort may be the result of the amount of cognitive capacity that is at the disposal of the individuals. Greater stability in decision-making for professionals, such as managers, is likely to be experienced when individuals are allowed to work at their optimal levels. In other words, the study ensuring that individuals have access to adequate cognitive resources can reduce framing. It also helps emphasise the need to encourage individuals in various professions in domains such as medicine and policy-making to engage in the more systematic processing of information to overcome framing effects which are associated less conscious/heuristic processing of information. The nature of these domains is such that they are characterised by the need to make risky decisions, and hence the importance of paying greater attention to the available alternatives/options.

The present study provides new insights pertaining to factors that influence framing effects. It indicates that testing individuals at circadian congruent or incongruent times may lead to preference shifts for questions with the same outcomes due to differences in availability of cognitive resources. Individuals tested at their circadian incongruent times are at a higher risk of framing effects due to lower availability of cognitive resources required for more deliberate/conscious decision-making. The study however indicates that a number of other factors may still be responsible for framing effects, hence the need for further studies in this field.



## Chapter 5: General Discussion

### 5.1 Circadian Variations and Belief Perseverance

One of the aims of the thesis pertained to investigating the role circadian preferences plays on the ability of individuals to overcome belief perseverance. Based on existing research, a common view is that belief perseverance can be associated with the level of cognitive resources available. For instance, individuals who engage in intuitive thinking, which is characterised by the use of fewer cognitive resources, are more susceptible to belief perseverance (Evans & Stanovich, 2013). This should be the case, since overcoming belief perseverance requires greater use of cognitive efforts in order to challenge previously held views that may be incorrect or biased (Jelalian & Miller, 1984; Guenther & Alicke, 2008).

Within the above perspective, this thesis, as evident from study 1, suggested that the amount of cognitive capacity available to an individual during a certain time of the day could potentially influence his or her ability to attenuate belief perseverance. From the literature review, circadian variations constitutes as one of the factors that can influence cognitive resources that are available for processing information in tasks that require the utilisation of working memory (Stevens et al., 2011). Accordingly, belief perseverance among the study participants was tested at circadian congruent and incongruent times, when cognitive resources are likely to vary based on whether one is a morning type or evening type.

Prior to presenting disconfirming information about the suspect's guilt, study 1 showed no significant differences among participants tested during congruent and incongruent times. Moreover, both groups of participants significantly revised their initial guilt judgements after being debriefed with disconfirming information. It should, however, be noted that participants tested at their circadian incongruent times were characterised by a significantly smaller downward revision of their suspect guilt judgements compared to participants tested at their circadian congruent times. The presence of significant differences in study 1 thus

supports the hypothesis that belief perseverance is reduced when participants are tested at their optimal time of circadian preferences compared to testing at circadian incongruent times.

The findings on the significant association between circadian variations and belief perseverance in study 1 corroborate previous research on the influence of cognitive efficiency on making judgements. Bodenhausen (1990), as highlighted in the literature review, for instance, demonstrated that stereotyping is exacerbated when individuals were tested at their circadian incongruent times due to reliance on heuristic type of thinking. Nestler (2010) also found that individuals have fewer cognitive resources available at their non-optimal circadian times. Furthermore, it can be argued that the higher levels of belief perseverance among individuals tested at circadian incongruent times indicates greater reliance on System 1 type of thinking that mainly works independently from working memory (Kahneman, 2003). For participants tested at their circadian congruent times, the higher levels of belief perseverance attenuation suggest, as predicted in prior research (e.g. Evans, 2008; Evans & Stanovich, 2013), that more deliberate thinking was used while incorporating the disconfirming information. Therefore, individuals with greater cognitive resources available to them are better placed to consider alternative hypotheses or explanations.

Prior research, as reviewed in the present study, further suggests that differences in the influence of circadian preferences on decision-making may be dependent on the complexity of the task at hand (Kahneman, 2003; Drummond et al., 2001; Harrison & Horne, 2000). For less complex tasks, the level of availability of cognitive resources based on circadian congruence may have no significant influence on making judgements. In the present study, the presence of significant differences in belief perseverance among participants in study 1, who were tested at their circadian congruent and incongruent times, indicates that the task of rating the suspect's guilt level and incorporating disconfirming evidence is highly complex.

For such tasks, higher levels of cognitive efficiency are required to help overcome cognitive bias and attribution errors (Nisbett & Ross, 1980). Ideally, it also means that people working at their non-optimal times are inclined to form judgements that affirm, as opposed to challenge, the validity of their existing predispositions, and, in the process, satisfy the belief perseverance principle.

It should, however, be noted that the influence of circadian variations on belief perseverance may not hold in all situations. This was demonstrated in study 2, in which case, no significant influences were observed despite the participants in the two experiments being presented with the same offender profile. The suggestion, therefore, is that in an instance where an existing belief is deep-rooted (e.g. characteristics of a sex offender), circadian preferences may not perform a significant influence on belief alleviation. In this case, some beliefs may not be considered as mistaken or illogical, since some evidence may be observable from everyday experience or knowledge of certain behaviours. For example, some people could erroneously believe that obesity among most people is caused by overeating. Such a belief could be attributed to encounters with obese people, who also tend to overeat. Counter-arguments indicating that obesity is also strongly influenced by other factors such as genetic makeup, lack of opportunities for physical exercise and lack of access to healthy foods could, therefore, be rejected. In such instances, it requires more than the availability of cognitive resources to attenuate the beliefs.

Study 1 and 2 further suggest that the presence of high levels of confirmation bias among some individuals could limit the extent to which circadian preferences influence belief perseverance attenuation. The existence of confirmation bias is evident when an individual tends to search for information that will support an initial or existing view (Sanderson, 2009). In greater detail, when an individual has existing expectations about a particular process or aspect, he or she will tend to acquire little information that could lead to the disapproval of

existing assumptions. The individual will, therefore, give over value assumptions-confirming evidence while undervaluing any assumption-disconfirming evidence (Proctor & Capaldi, 2012). As an example, an individual may assume that left-handed individuals are more creative than right-handed individuals. All encounters involving left-handed people that are creative are therefore likely to be interpreted as confirmatory evidence of existing beliefs. On the other hand, any information that could discount such a belief could be easily discounted. In such cases, the extent of cognitive efficiency based on circadian variations could fail to have an impact on attenuation of existing beliefs. The line of argument here suggested that beliefs were slightly held by participants in study 2 as compared to study 1.

Furthermore, the differences in the study 1 and study 2 results could be attributed to the fact that certain individuals have higher levels of general and emotional intelligence. According to a study conducted by Lam and Kirby (2002), it was discovered that their emotional and general intelligence levels had an influence on the amount of cognitive capacity was available to an individual. The levels of intelligences were not tested in this study and it could be that the participants of study 2 simply had higher levels of intelligence. Hence, the participants of study 2 could have made a sound decision in the first part of the study and therefore, no significant change in belief perseverance was found after the discrediting of the initial information.

## **5.2 Socially Distributed Thinking and Belief Perseverance**

Besides circadian preferences, the amount of cognitive capacity available for processing complex tasks can be augmented through socially distributed thinking. In other words, groups of people working together are likely to have greater cognitive resources for processing information compared to individuals working on their own (Semin & Smith, 2013). As mentioned earlier, this possibility was examined in study 1, by testing two conditions (i.e., the impact of individual and groups) on belief perseverance at circadian congruent and

incongruent times. Unlike individual testing at circadian congruent and incongruent times, group judgements were characterised by less belief perseverance, both at congruent and incongruent circadian times of testing. Hypothesis 1b, which suggested that participants in a group would depict less belief perseverance than individuals when tested at both circadian congruent or non-congruent times, is therefore affirmed.

In essence, the findings on lower susceptibility to belief perseverance in groups compared to individuals when tested at circadian incongruent times provide support for existing theories, and empirical work on socially distributed cognition. Prior studies such as Cornelissen and Clarke (2010) and West (2007) have, in this context, argued that collective cognition is distinct from individual cognition. Precisely, collective cognition has a more superior impact on decision-making by increasing cognitive efficiency levels. Furthermore, the greater ability among group participants to overcome belief perseverance compared to individual participants provides partial support for the claim in the hypothesis of extended cognition that cognition is not limited to the individual brain, but also extends to one's environment (Spaulding, 2011; Sutton, 2010; Clark, 2008). Therefore, creating platforms where complex problems can be solved through group work enhances the chances of successful results due to the higher levels of cognitive efficiency.

A number of alternative explanations can also be put forward, in relation to the possible causes of lower belief perseverance, among group participants after presentation with the atypical offender profile. First, the group discussions provide a platform for sharing their views, and hence a more critical evaluation of an issue at hand. In line with this view, prior research, as reviewed in this study, indicates that, in socially distributed cognition, feedback from other individuals influences the decision-making processes through consideration of additional information (Blanchette & Richards, 2010; Xue et al., 2010; Glockner & Witteman, 2010). The extra information plays an important role in reaching a conclusion that

is based on a comprehensive evaluation of all key issues. Second, groups, unlike individuals, form a consensus that is devoid of distorted perceptions about the issue under consideration. Wright et al. (1996) and Olsson et al. (2006), within this context, mention that the collective cognitive resources that are at the disposal of individuals' in-group help overcome the effect of insufficient weight that often leads to inaccurate judgements.

It can also be noted that group judgements were not significantly revised when tested at circadian incongruent times. It therefore means that "groupthink" did not have a significant influence on the final judgement. Additionally, this finding suggests that the presence of a greater pool of cognitive resources, that results from socially distributed cognition, helps overcome the tendency to make use of intuitive thinking when cognitive resources are depleted. Put differently, socially distributed thinking helps maintain higher cognitive efficiency, even in instances where individual cognitive resources are insufficient (Xue et al., 2010; Blanchette & Richards, 2010).

Despite the positive impact, it can be noted that socially distributed thinking is not cost free. In greater detail, the efficiency at which socially distributed thinking leads to higher cognitive performance is influenced by three cost structures: cost of mental operations, cost of outer operations and cost of coordinating inner and outer processes (Kirsh, 2010; Cowley & Vallée-Tourangeau, 2013). The present research reduced cost of outer operations by allowing group participants to evaluate information on the suspect's guilt in a collective way. Therefore, it can be argued that the superior performance of the groups, in terms of attenuating belief perseverance, when tested at circadian incongruent times, can be attributed to the socially distributed cognition, reducing the effects of cost of inner cognitive resources and the coupling costs. Therefore, socially distributed thinking has vital importance in relation to the level of sense making and taking effective actions (Cowley & Vallée-Tourangeau, 2013).

For researchers seeking to extend research in this area, coupling costs could be increased in order to determine whether groups would still be able to exhibit less belief perseverance when tested at circadian incongruent times. One way in which this could be accomplished would involve presenting information on the suspect guilt profile to single thinkers, who should then aggregate it in order to produce a collective output in the form of an overall guilt judgement for the group. This is in contrast to presenting the information to all group members to be debated collectively. Presenting the information to the single thinkers increases the coupling costs, since every single individual has to think on his or her own, leading to differences in propositions which must then be coordinated in order to produce the most optimal aggregated judgement. In such a case, it would be expected that the increased cost of coordination, especially circadian incongruent times, would result in more belief perseverance.

The findings on reduced belief perseverance among groups also have implications on methods that can be used to enhance cognitive efficiency. Social cognition, which is achieved by requiring individuals to work under groups, can help in suppressing erroneous beliefs by improving the level of control over habitual or automatic responses that are associated with heuristic thinking (Mannix, Neale, & Goncalo, 2009). In some instances, social cognition can be achieved by enhancing cognitive efficiency. For example, individuals should be exposed to cognitive training that targets specific cognitive abilities such as working memory, speed of processing, divided attention and response inhibition. In studies where such training has been examined, it has been shown that participants in the treatment group tend to display higher cognitive efficiency compared to participants in the control group (Ignjatovic, Kalabic, Batic, & Zikic, 2015; Hardy et al., 2015).

### 5.3 Type of Reason Given and Belief Perseverance

Besides circadian variations, the present study investigated the impact that type of reason given – against or in support, is in relation to belief perseverance and the implications in a legal context. Nestler (2010) highlighted in the methodology that the participants were required to rate the extent to which they believed the suspect was guilty and the degree of confidence in the accuracy of their judgement. The effect of type of reason given on belief perseverance was examined by asking half of the respondents to provide reasons why the suspect might be the offender, and the other half, five reasons why the suspect might not be the offender. The participants were then briefed regarding the atypical profile of the offender, and asked to provide a second confidence judgement. The mental alertness and involvement levels were also established.

Contrary to expectations, the findings indicated that type of reason given has no influence on belief perseverance. As such, the findings from the study does not provide adequate support for hypothesis H2a, that participants tested at their circadian incongruent times find it hard to generate reasons in favour of a known outcome and hence less belief perseverance. Similarly, hypothesis H2b which states that participants tested at their circadian congruent times finds it easier to generate reasons in favour of a known outcome, hence more belief perseverance is not sufficiently supported despite not being contradicted. Hypothesis H2c and H2d on ease of difficulty of generating reasons for or against when tested at circadian incongruent times are also not supported. In contrast, other studies (e.g. Anderson, 1983; Davies, 1997) reported that ease of generating explanations could enhance belief perseverance while difficulties in generating explanations often prompt individuals to reconsider their earlier beliefs and hence a possible reduction or elimination of perseverance.

Several explanations have been suggested for the observed results. First, it is likely that the participants could find it easy to generate reasons for their belief based on accessible



content and previous experiences. Therefore, no difficulties may be encountered in generating many reasons, thus leading to the persistence of the belief. Greifeneder and Bless (2007) reported similar findings, in which case individuals with high process capacity depicted the tendency to base their judgement on accessible content information. Second, attitude formation could impact on the ease of generating reasons for or against certain aspects under consideration. Haddock (2002), for instance, found that individuals who are well versed in particular areas, such as politics, were unaffected by number and type of accessed attributes. In other words, they could easily generate positive or negative attributes, and hence unlikely to change their initial beliefs. Similarly, Schwarz et al. (1991) found that individuals who can easily generate or recall information are likely to rate themselves as assertive in a certain area, and hence, it is a very slight chance for them to change their beliefs, thus suggesting that they relied more on availability bias.

Cognitive efficiency was, on the other hand, investigated by measuring the participants' mental alertness and levels of involvement. The findings on indicating that cognitive efficiency parameters did not vary significantly based on whether the participant was tested at circadian congruent or incongruent times. This view is contradicted by Schwartz et al. (1991), they reported that individuals operating at their circadian congruent times are likely to experience significantly less difficulty in making judgements and are less susceptible to heuristics thinking. The study by Wright et al. (2002) also indicated that circadian variations could be the reason behind differences in performance for the task requiring higher levels of focused attention and working memory, but this finding is not fully supported in the outcomes of study 1 and 2. Schmidt et al. (2007) had further indicated that circadian variations could lead to inferior performance among individuals required to perform certain tasks at their non-optimal circadian times.

The studies suggested that the effect of circadian variations has on cognitive efficiency could be due to the presence of other factors that also play a role in mental performance. Such factors, as identified earlier, include depression, adapting to external demands and genetic makeup (Forni et al., 2014; Goel et al., 2013). The level of task difficulty could partially explain the absence of differences between the participants based on their circadian preferences. For example, some participants might have found it equally easy to generate many reasons for or against based on their initial judgements. However, a single sample *t*-test was conducted to identify if there was a statistically significant difference in the level of task difficulty between the participants based on their circadian preferences. There was a general lack of difference found for participants tested at their circadian incongruent times ( $M = 6.04$ ,  $SD = 2.80$ ) and circadian congruent times ( $M = 5.60$ ,  $SD = 2.66$ ) conditions,  $t(159) = 1.97$ ,  $p = 0.27$ .

From another perspective, the findings indicate that participants tested at their circadian congruent times experienced slightly higher levels of difficulty in making judgements, which is consistent with past research on thinking processes. In this case, the findings support the view that circadian congruency facilitates System 2 thinking, which is more deliberate and analytical. Unlike System 1 heuristic thinking, the analytical thinking process is more time consuming, rule-based and necessitates mental simulation and use of complex emotions (Kahneman & Frederick, 2002; Evans & Stanovich, 2013). Collectively, these aspects of analytical or deliberate thinking make it difficult for an individual to arrive at a judgement.

#### **5.4 Implications of Belief Perseverance for the Legal Context**

The findings on the inability of some individuals to overcome belief perseverance, even after presentation with counterarguments or discrediting information, have significant implications in the legal system. One of the legal contexts that could be impacted by biased attitudes pertains to courts of law. In most cases, juror judgements make allowances for pre-

trial and trial biases during the decision-making processes. When such biases are not adequately taken into consideration, there is a chance that they could negatively influence judgements such as a suspect's guilty verdict. Prior research in this area has demonstrated that once biases are formed, they impact the ways in which information is presented during trials. This affects how jurors, and other stakeholders involved in the legal system attend to, process, recall and weigh on the information (Carlson & Russo, 2001; Jones & Kaplan, 2003).

The results of the study indicating higher levels of belief perseverance for individuals tested at circadian incongruent times are also manifested in the legal system. Moran and Cutler (1991), and Kunda and Sinclair (1999), for example, found that certain individuals often encounter difficulties in detecting and evaluating their own biases in courtrooms. In such cases, the individuals' pre-trial attitudes that become discredited during the trial processes undermine their satisfaction with the outcomes of the justice process. Regarding fairness of verdicts, relying on biased information and attitudes that fail to be attenuated during the trial could have had a negative influence on verdicts. Along these lines, Kaplan and Miller (1978) found that sources of legal information, such as case summaries and trial transcripts, are often laden with biases that prosecutors and judges should be keen to identify and help overcome in order to give fair verdicts.

Given that biases in these sources of information may not always be overcome effectively, researchers have suggested the use of other sources that are less susceptible to biases. Ross, Dunning, Toggia, and Ceci (1990), and Diamond, Murphy, and Rose (2012), for example, argue that courts are more likely to reach more accurate judgements if they make use of videotaped trials. Such trials contain more legally relevant information, compared to transcripts and case summaries, leading to fewer extralegal biases that could influence the verdict in undesired ways. Arguably, the use of videotaped trials supports the concept of

socially distributed thinking. As reviewed in Chapter 1, a socially distributed cognitive system contains external representations (Spaulding, 2011; Giere, 2007). Such representations are not localised in a person's brain, but contribute immensely towards increasing cognitive efficiency. As such, videotaped trials are external representations of the cognitive system that can assist in the process of making reliable judgements that are not based on erroneous attitudes and beliefs.

From another perspective, the results reported here, as discussed earlier, suggested that participants find it easier to generate reasons in favour of a known outcome, and hence displaying more belief perseverance especially when tested at their circadian optimal times. The underlying cognitive biases in such a context have also been observed in legal cases. In particular, cognitive biases in the form of hindsight bias, also known as the "knew-it-all-along effect", could impact on the extent to which an investigation and verdict is thorough and fair. According to Cutler (2007), hindsight bias is evident when an individual makes use of information obtained after an event to make conclusions that the eventual outcome was inevitable, while this may not be necessarily the case. Therefore, the knowledge of an outcome predisposes an individual to emphasise evidence that matches with the outcome. The individual also minimises the use of discounting evidence that is deemed to be inconsistent. This explains the inability of the study participants to generate reasons against when the outcome was known. When taken into the context of criminal cases, cognitive processes that lead to hindsight bias would lead to investigators such as prosecutors, police and judges making conclusions that a certain suspect was guilty from the beginning. This is because the evidence against the suspect is enhanced. This bias has a negative impact on the justice processes, as it makes the court officials focus on only that individual as the main suspect, while failing to consider other leads.

The witnesses to a certain criminal case may also be influenced by belief perseverance when testifying. Specifically, certain cognitive biases influence the ability of a witness to make an accurate assessment, or confidently make an identification of a witness. By way of example, an eyewitness may only have had a fleeting glimpse of an assailant. The poor visual sight at night could, for example, lead to the witness having a poor memory or mental picture of the assailant. If the witness is subsequently provided with clear images of a suspect, for example, through an identification parade, he or she might make a replacement of the poor image with the clear one from the parade. It can, however, be that the identification is wrong. In such a situation, the witness may, in hindsight, make use of the clear image and confirming feedback to confidently claim that he or she actually saw the assailant. In order to overcome such bias, it is important that jurors be proactive in reviewing the validity of testimonies and convictions. This can help identify possible errors arising from a bias that reflects belief perseverance. Such a review is particularly important before making final judgements, since realisation of strong evidence of erroneous biases after making of verdicts make it difficult to issue a reversal.

Previously, such cases of belief perseverance have been found to be common in court. Cutler (2007), for example, highlights a situation where an individual was convicted as guilty based on an assessment which indicated that the hair samples obtained from the scene of the crime had microscopic physical characteristics that were consistent with those of the suspect. However, later DNA testing proved, in a conclusive way, that the hairs were not those of the suspect. Despite the disconfirming evidence, the investigators and prosecutors belief about the guilt of the defendant persisted. In such a case, the inability to change previous beliefs results in a biased judgement. Consistent with this view, Ross et al. (1975) found that jurors may experience difficulties in complying with instructions that require them to disregard inadmissible evidence when more reliable evidence is obtained.

From the context of belief perseverance, such reluctance can be attributed to jurors' biased assimilation of information that is subsequently presented. The biased assimilation is particularly high when the information is in the form of counterarguments. Alternatively, the high levels of belief perseverance can be attributed to the generation of alternative explanations for the existing beliefs (Nadel & Sinnott-Armstrong, 2012). Such explanations enhance support for the belief, independent of the original foundation. While the presentation of new information could play an instrumental role in attenuating the erroneous beliefs, the cognitive processes dampens the effect. From a circadian variation point of view, it implies that jurors would need to utilise a higher amount of cognitive capacity in order to identify evidence that should be categorised as inadmissible. Therefore, jurors working at their circadian congruent times are more likely to be keen on challenging inadmissible evidence that is based on biased beliefs.

In relation with the study findings, research also points out that jurors who come to courts with pre-existing beliefs about certain issues about the requirement of the law may be predisposed to belief perseverance. The beliefs may be derived from long-term exposure to sources of information, such as media and legal commentaries, among others. Over the course of time, the exposure leads to ideas and views from these sources being firmly entrenched in the juror's mind (Krivoshey, 2014). Jurors who are unable to adequately confront such beliefs may use them as rule of thumb, and hence make decisions that are not entirely objective. Further, it is likely in some cases that jurors may erroneously rely on the defendant's past criminal record to make a current conviction. According to Krivosney (2014) when preconceived notions from past criminal record of the defendant are congruent with jury instructions, it is likely that the juror will rely on such notions to make judgements. In contrast, when preconceived notions are incongruent with the instructions, jurors are less

likely to make use of such notions to make decisions. This implies that belief perseverance is likely to persist when information supporting an existing belief exists.

The previous work on belief perseverance in judicial behaviour has, however, not comprehensively been investigated in regards to the role that cognitive resources which could influence circadian variations performance in order to overcome existing beliefs. In this light, it can be suggested that, when making judgements, it is important that jurors give greater attention to evidence, and less on pre-existing attitudes that may not be entirely objective. Furthermore, jurors could seek to eliminate biased decisions by enhancing their levels of collaboration during the deliberation process. Collaboration is consistent with the concept of socially distributed thinking, in which case, the combined cognitive resources make it easier to identify and neutralise cognitive bias (Burke, 2006).

The need for jurors to make use of socially distributed thinking is further supported by research, indicating that they tend to have possession of limited cognitive resources. Martin, Set, and Crelia (1990) observed that jurors are exposed to highly demanding trials characterised by the presence of large amounts of inadmissible evidence, corresponding instructions from judges to disregard such evidence, as well as multiple cases, of confusing evidence and arguments. While corroborating these views, Nadel and Sinnott-Armstrong (2012) admit that jurors work in a complex environment. Specifically, the need to listen, process and make conclusions from large amounts of information can be taxing on the jurors, in that it leaves them with fewer resources. Adequate cognitive resources are required to facilitate more effortful and deliberate processing of information in order to identify inadmissible evidence. Therefore, socially distributed thinking can help boost the availability of cognitive resources.

### **5.5 The Effect of Circadian Variations and Framing Effect on the Three Framing Problems**

The final study sought to establish whether circadian variations have an influence on risky choice framing, in relation to the Classic Asian Disease, Lung Cancer and HIV Virus framing problems. The study participants were evaluated for framing effects based on their morningness and eveningness orientation. From the review of the relevant literature, it was expected that participants tested at their circadian congruent times would be able to expend more cognitive efforts in evaluating the choices compared to their circadian incongruent participants, and hence resulting in lesser framing effects. The rationale for this expectation is that individuals operating at their optimal circadian times have access to greater amounts of cognitive capacity, resulting in greater levels of alertness when making judgements. Other aspects that were taken into account include the level of confidence depicted by the participants in making their decision and the extent of cognitive reflection.

One focus area in need of elaboration is the demonstration of changes in their risky choice preferences for the Classic Asian Disease, Lung Cancer and HIV Virus framing problems. This is where the frames -gain or loss- are introduced. From the results, participants who were first presented with a gain frame were mainly neutral in their choice of either Treatment A or B. A similar pattern was also found for participants who were first introduced to the loss frame, and later to the gain frame. The implication, therefore, is that the order of presenting frames does not have a significant impact on the risky choice preference. Put differently, the study results do not reveal the presence of significant interactions between order and frame. Other scholars, such as Martinussen (2016) also reported similar finding: the sequence of gain or loss frames did not have a significant influence on risk seeking and loss aversion.

The above finding, however, contradicts a number of other studies on framing effects. Schwarz (1999) for example, found that when the sequence of alternative was changed, the risky option (losing lives) was chosen by fewer participants who had been first presented



with the gain framework. In contrast, more than half of the respondents choose the risky frame when they were first presented with the lives lost frame. In this case, manipulating the respondents' sequence of alternatives either gain first or loss first- triggered a significant change in preferences. In their study, LeBoeuf and Shafir (2003) also found that the majority of the study subjects chose the risky option when first presented with the loss frame, and only a minority considered choosing the risky option when first presented with the gain frame.

Task involvement was measured to assess the extent to which participants were cognitively engaged in choosing the alternatives from the Classic Asian Disease, Lung Cancer and HIV Virus framing problems. From the results, a slightly higher level of involvement for the cognitive reflection task was evident from the participants who were tested at their circadian congruent times. The difference with the task involvement levels of the participants tested at their non-optimal circadian times was not statistically significant. However, it implies that operating at one's optimal times enhances the amount of cognitive efficiency, and hence developing higher levels of attention and ability to engage in deliberative thinking. Other scholars such as Valdez et al. (2012) and Bodenhausen (1990) have previously reported that circadian congruency improves the cognitive capacity through access to a greater amount of resources. Some consistency is, therefore, evident between the present findings and earlier work on the cognitive impact of circadian variations.

It can, however, be noted that no significant interactions were shown between the CRT scores and mean risk preferences for participants in both the gain and loss frames. This can in part be attributed to the low CRT scores that were obtained from all participants. In parallel with these results, Peters and Levin (2008) in a prior study found that although individuals with higher critical thinking and numeracy skills are likely to be less susceptible to framing effects, the differences relative to counterparts with deficient skills in these areas are not always significant. Notwithstanding such possibility, a few studies have demonstrated that

individuals with more reflective skills are not highly predisposed to framing effects. The studies by Oechssler et al. (2009) and Frederick (2005), for example, found that participants with high CRT scores have significantly low framing effects, due to relying greatly on conscious and deliberate thinking processes. Framing effects were found to be robust among participants who relied on more automatic processing.

The study's hypothesis 3a proposed that the participants tested at their circadian congruent times are less susceptible to framing effects in the Classic Asian Disease, Lung Cancer and HIV Virus framing problems. The results of the study confirm this hypothesis. Specifically, the study finds that participants who were tested at their circadian optimal times did not make significant revisions in their judgements in both the gain and loss frames. The mean scores remained at the neutral level for Treatment A or B. By contrast, participants who were tested at their non-optimal circadian times depicted risk aversion behaviour for the gain frame in Treatment A, and shifted their preference to the risky Treatment B in the loss frame. The presence of framing effects among the participants tested at their incongruent circadian times confirms hypothesis 3b and are consistent with prior research, indicating that people tend to be risk-averse in gain frames and risk seeking in loss frames (Tversky & Kahneman, 1981; Mahoney et al., 2011).

The finding on framing effects further supports the view that human cognitive systems are highly sensitive to information that is negatively framed. Specifically, negative information tends to override the effects of positive information, hence the inclination to risk-seeking behaviour in loss frames (Acton, 2013; Lupfer et al., 2000). It could also be that the framing effects are the result of the activation of congruent schema from the participants' long-term memory (Olekalns & Smith, 2005; Gigerenzer et al., 1991). In this case, presenting negatively framed information triggers a memory of similar instances, which demanded that risk-seeking behaviour is adopted to minimise the potentially negative outcomes.

The lack of framing effects among participants tested at their circadian congruent times correlates to several studies on cognition. Olekalns and Smith (2005), for example, highlighted that framing effects are likely to occur as a result of reliance on alternatives from one's cognitive causal schema. When larger amounts of cognitive resources are available, individuals are less inclined to engage in selective processing of information during decision-making. Therefore, framing effects are less likely to be evident for individuals operating at their circadian optimal times. Studies focusing on need for cognition have also demonstrated that individuals who can put more effort in processing tasks are characterised by lower framing effects (Smith & Levin, 1996; Chatterjee et al., 2000; Curseu, 2006). This also means that System 2 thinking, which is associated with analytical and deliberative thinking, can help reduce framing effects among people.

Both Positive and Negative framing can have a range of practical implications in various settings. From a health perspective, gain-framed information is meant to motivate the societal members to protect themselves from certain health hazards, but may not be adequately effective in motivating the public to avoid certain practices. Specifically, the gain-framed stories are unlikely to provide strong and compelling reasons for individuals to take an active role in health issues. In such a case, Negative framing, in the form of threats, helps increase people's guilt levels leading to higher motivation to act (Major, 2011). In greater detail, loss-framed messages lead to high guilt appeals among the targeted individuals, and are therefore more persuasive in terms of societal responsibility of health issues.

This framing effect does not, however, have the same impact on all health issues. In health detection behaviours the expected outcome is risky, and better levels of persuasion are achieved when loss-framed messages are used. Conversely, in situations where health prevention behaviours have certain and risk-averse outcomes, it is better for policymakers to make use of gain-framed messages. Gain-framed messages can be used to encourage

preventive behaviour in aspects such as physical activity, the use of sunscreen and smoking cessation (Gallagher & Updegraff, 2011). In a more specific example, gain-framed messages that advocate for physical activity as a way of preventing obesity are more effective than equivalent but loss-framed messages that emphasise that becoming obese is an outcome of lack of physical activity (Rothman & Salovey, 1997). It can, therefore, be concluded that framing of messages should be tailored to suit the intended outcomes.

The framing effects can also be used to help understand how different individuals arrive at consensus during negotiations. In most cases, negotiators make their decision after presenting with the outcome as either a gain or a loss, thus determining their demands (Kahneman & Tversky, 1979). Negotiators who consider their outcome as a gain are likely to demand relatively low prices when making sales, while those who perceive their outcome as a loss tend to demand relatively high prices. The overall outcome is a negotiation impasse. Therefore, negotiators expecting gains are likely to be risk seeking while their counterparts who expect losses are likely to depict loss aversion behaviour (Bottom, 1998; Neale & Bazerman, 1991). Understanding these psychological issues can help individuals approach negotiations in such a way that their demands are met.

### **5.6 Framing Effects Study Limitations**

The present study on framing effects from the context of circadian preferences makes several contributions to this field of research. However, there were several limitations in the methodology employed that future research could seek to overcome. First, the focus on only a few areas Classic Asian Disease problem, HIV and lung cancer limits the generalisability of the findings to other areas. This is especially the case for fields that do not involve risks that are similar to those in the field of public health. Therefore, further studies that make use of circadian variations are required in order to determine whether circadian preferences and

their influence on framing effects can be replicated in other domains besides the Asian Disease, Lung Cancer and HIV Virus framing problems.

Second, the consideration of only one issue in the experiment may have limited the amount of cognitive efforts that the participants expended in making their judgements. To better understand the impact that circadian congruency and incongruent testing have on framing effects, the participants may, in future, be required to make decisions for a larger number of issues. For example, 8 to 12 message frames could be used. It is expected that a larger number of message frames increases demand for higher levels of cognitive efforts and efficiency, and hence the impact of more cognitive resources in circadian optimal times, compared to the non-optimal times, could be more visible.

Besides establishing the level of task involvement, future studies may also measure the response time used while making a decision on framing effects. Such measurement can help in further establishing whether participants, based on their circadian preferences, make use of heuristic thinking, which is characterised by faster responses compared to analytical thinking, which is more time-consuming. The outcome is greater in support for research on dual process cognition in relation to circadian variations.

Lastly, framing effects, as mentioned earlier, were only observed among participants tested at their circadian incongruent times. For the other condition on circadian congruent times, the findings did not reflect consistency with the general argument that gain frames are associated with risk aversion, while loss-frames are associated with risk seeking (Cassotti et al., 2012; Levin et al., 1998). Such findings highlight the need for researchers to take into consideration other factors that predispose individuals towards making a biased judgement. Such factors may include the individual's interest in the issue at hand, the level of emotional arousal and affective levels among others (Nabi, 2003; Martinussen, 2016).

## 5.7 Conclusion

Overall, this thesis sought to examine the influence that circadian variations and socially distributed cognition have on belief perseverance and framing effects. Circadian variations have been shown to have an influence on an individual's morningness-eveningness orientation. The variations also affect the amount of cognitive capacity that are available for processing of information and tasks that require higher levels of cognitive efficiency and working memory. On one hand, the thesis finds that circadian variations do indeed have a significant influence on belief perseverance in which case participants tested at their circadian congruent times were characterised by less belief perseverance, compared to their counterparts tested at their non-optimal circadian times. The thesis links the presence of such impact on belief perseverance to the ability of people with more cognitive resources to take into consideration counterarguments and discrediting evidence through a thinking process that is more analytical and deliberate.

By contrast, people who are mentally exhausted due to the requirement to perform tasks at their non-optimal circadian preferences tend to rely on heuristic thinking that is automated and less conscious. In other words, cognitive deficiency brought about by circadian variations at non-optimal times reduces the level of mental alertness and attention that is required to help attenuate belief perseverance that is based on cognitive bias and attribution errors. On the other hand, one of the experiments in the study suggest that while operating based on circadian congruent times help attenuate belief perseverance. The impact is not statistically significant relative to circadian congruent times. This partial support for the influence of the circadian variations on belief perseverance could be explained by the extent to which the task at hand is deemed to be complex by the study subjects.

The thesis also concludes that socially distributed cognition can be used as an effective approach for attenuating belief perseverance. Participants who were tested in groups

demonstrated greater confidence in their judgements, and were also characterised by lower revision of their judgements when presented with the atypical profile of the offender compared to participants working individually. This thesis also attributes the lower levels of belief perseverance in groups to the supplementation of individual cognitive resources. In this case, individuals working as a group can engage in more effortful thinking by combining their cognitive resources. This positive impact is evident even in instances where participants working in groups are tested at their non-optimal circadian times.

From the legal perspective, it can be concluded that jurors should be keen to identify situations where belief perseverance may influence their decision-making. Whenever jurors have preconceived notions about the defendant, it becomes easier to generate reasons that are consistent with such notions compared to reasons that go against the notions. The study findings suggest that similar effects may be evident among witnesses, police, prosecutors and other members of the justice systems. Further, it has been argued that belief perseverance can lead to unfair convictions and judgements. Even in instances where the verdict is corrected after gaining access to reliable evidence, the affected parties may still hold on to their initial beliefs. Jurors are especially at the risk of belief perseverance due to the tight schedules and cognitive demanding decision-making roles. To overcome belief perseverance, greater collaboration among jurors and other agencies in the justice systems is required. The collaboration process helps exploit the positive effects of socially distributed cognition.

A number of observations have also been made with respect to circadian variations and the influence on framing effects. The thesis reveals that participants tested at their circadian congruent times are less susceptible to framing effects. In other words, the decisions made by these individuals are independent of the presentation of information in either gain or loss frames. By contrast, individuals required to perform tasks at their non-optimal circadian times are at the risk of framing effects, in which case gain-framed messages are associated

with risk-averse behaviour, while loss-framed messages are associated with risk-seeking behaviour. In terms of application, the thesis indicates that framing effects can be applied to achieve a desired social health outcome. Policymakers can use gain-framed messages to persuade the public to undertake health behaviours that are associated with positive outcomes. On the other hand, loss-framed messages can be used to motivate the public to engage in preventative behaviours when the health outcomes under consideration are considered to be negative.

In conclusion, various studies have suggested that circadian variations could have a significant influence on the ability of people to make correct and unbiased judgements in tasks that require high levels of cognitive efficiency. It is recommended that further research be conducted in order to evaluate the influence of circadian variations when the workload is significantly increased or time required to perform the task is reduced.



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## Appendices

### Appendix A<sub>1</sub>

#### Questionnaires

##### GRULaK: Questionnaire (Group)

*Please take your time to read this information carefully this will encourage you to use your time and reach a decision in a timely manner.*

#### **Incident information**

**Please consider the following information that provides details on a series of sexual assaults, which occurred on the 14<sup>th</sup> April 2002, 25<sup>th</sup> May 2002 and 10<sup>th</sup> July 2002.**

**Interviews were conducted with the three female victims aged 11, 12 and 10 years old respectively.**

**Imagine that you are acting as the Senior Investigating team in charge of investigating this series. Please read over the subsequent materials and answer the associated questions.**

#### **Suspect description**

The man responsible for these attacks is estimated to be tall, between 6ft and 6ft 3 inches in height. He speaks with a local accent and with a calm voice. His hair is either brown or dark blonde. He is pale skinned and has a tattoo on his left arm.

#### **Offence description**

All the victims were walking home from school when the offender who was wearing a hood, or shirt around his face or in one offence dark glasses, grabbed them securely from behind and blindfolded them. The victims were all lead to a secluded spot indicating that the offender has knowledge of the local area. He tells the victims not to make any noise, cry or resist his efforts. He then removes their clothes and demands that they kiss him. He fondles the victim and attempts intercourse. After getting the victim to put their clothing back on he guides them away from the secluded spot, warns them not to look and leaves quietly and calmly.

#### **Suspect information**

Following the media broadcast of the suspect description; the following individual has been brought to your attention.

**Suspect A** is a 44 year old white male who is 6ft 2 inches tall, has dark blonde hair and has a tattoo on his left arm. Further inquiries have revealed that he is currently single and he is described by local people as insecure with women, although, he has had one previous relationship with a woman which lasted 6 months. He lives alone in an apartment complex half a mile from where the crimes took place and he grew up in the local area, which is reflected, in his accent. He is currently unemployed and inquiries in local pubs reveal that he is a fairly heavy user of alcohol. He was brought up in a poor, working class family and he dropped out of school at 15 before taking his O-levels. Local people described him as having a short temper and a tendency to be quite aggressive. A search of his home revealed that he had a large collection of pornography.

**Your team must discuss this case for 10 minutes, and decide whether you think this suspect is the offender. MAKE SURE YOU REACH A COMMON OPINION. If you cannot agree, take the opinion of the majority as the group opinion. Please report your answer below.**

**Please rate, based on the available information, the degree to which Suspect A may be guilty of this series of offences?**

*Please answer by putting a mark on the line below. Put a mark near the left end if you believe the suspect is not guilty at all. Put a mark near the right end of the line if you believe the suspect is completely guilty. Put a mark at an intermediate position if you believe the extent to which the information indicates that the suspect is guilty lies somewhere in between.*

**Not at all** o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Completely**

**Please rate, based on the available information, the degree to which you feel confident that your judgement is correct?**

*Please answer by putting a mark on the line below. Put a mark near the left end if you do not feel confident at all that your judgement is correct. Put a mark near the right end of the line if you feel completely confident that your judgement is correct. Put a mark at an intermediate position if your confidence in the correctness of your judgement lies somewhere in between.*

**Not at all confident**      o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Completely confident**

**Profile information**

Due to the serious nature of this offence, the following offender profile was compiled by a behavioural investigator to assist you in the apprehension of the unknown suspect:

In most crimes of this nature the offender is employed in some form of skilled or office job. The offender will usually be married, often with children of his own. The offender will be sexually exploratory and will probably have had several sexual partners. The offender will own a pornography collection. Most offenders live within 2 miles of the scene of the crime. Many offences of this type do not involve the use of alcohol or drugs. Offenders of this sort are often perceived by others as being quiet, self-assured individuals. Sex offenders of this nature try to avoid police attention and usually have no previous criminal convictions. Offenders typically appear to have normal moral and belief structures. Offences like this are characteristically committed by individuals of approximately 25 years of age (average). Most are aged under 30. This type of sex offender often has superficial charm, and will probably be fairly popular. The offender will probably have been educated beyond the age of 16 and is likely to have gone to university.

**Your team must discuss this new information for 10 minutes, and decide to what extent this should affect your original opinion of whether the suspect is the offender. MAKE SURE YOU REACH A COMMON OPINION. If you cannot agree, take the opinion of the majority as the group opinion. Please report your answer below.**

**Please rate again; based on the available information, the degree to which Suspect A may be guilty of this series of offences?**

*Please answer by putting a mark on the line below. Put a mark near the left end if you believe the suspect is not guilty at all. Put a mark near the right end of the line if you believe the suspect is completely guilty. Put a mark at an intermediate position if you believe the extent to which the information indicates that the suspect is guilty lies somewhere in between.*

**Not at all** o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Completely**

**Please rate, based on the available information, the degree to which you feel confident that your judgement is correct?**

*Please answer by putting a mark on the line below. Put a mark near the left end if you do not feel confident at all that your judgement is correct. Put a mark near the right end of the line if you feel completely confident that your judgement is correct. Put a mark at an intermediate position if your confidence in the correctness of your judgement lies somewhere in between.*

**Not at all confident** o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Completely confident**

**Please rate how much you felt involved with the case by putting a mark on the line below.**  
*Put a mark near the left if you did not feel involved at all and put a mark near the right end of the line if you felt greatly involved with the case. Put a mark at an intermediate position if you believe your involvement with the case lies somewhere in between.*

**No involvement** o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Great Involvement**

**Please rate how difficult it was to make a decision by putting a mark on the line below.**  
*Put a mark near the left if it was not difficult at all to make a decision and put a mark near the right end of the line if it was really difficult to make a decision. Put a mark at an intermediate position if you believe the difficulty of making a decision lies somewhere in between.*

**Not at all difficult** o-----o-----o-----o-----o-----o-----o-----o-----o-----o **Very difficult**

1) Participant N. |\_\_|\_\_|\_\_|

What is your age? |\_\_|\_\_|\_\_|

Please indicate if you are male or female:

Male |\_\_|

Female |\_\_|

---

2) Participant N. |\_\_|\_\_|\_\_|

What is your age? |\_\_|\_\_|\_\_|

Please indicate if you are male or female:

Male |\_\_|

Female |\_\_|

---

3) Participant N. |\_\_|\_\_|\_\_|

What is your age? |\_\_|\_\_|\_\_|

Please indicate if you are male or female:

Male |\_\_|

Female |\_\_|

---

4) Participant N. |\_\_|\_\_|\_\_|

What is your age? |\_\_|\_\_|\_\_|

Please indicate if you are male or female:

Male |\_\_|

Female |\_\_|

---

*For office use only:*

*Time: \_\_ : \_\_*

*Total time: \_\_ : \_\_*

**GRULaK: Questionnaire (Individual)**

*Please take your time to read this information carefully this will encourage you to use your time and reach a decision in a timely manner.*

**Incident information**

**Please consider the following information that provides details on a series of sexual assaults, which occurred on the 14<sup>th</sup> April 2002, 25<sup>th</sup> May 2002 and 10<sup>th</sup> July 2002.**

**Interviews were conducted with the three female victims aged 11, 12 and 10 years old respectively.**

**Imagine that you are acting as the Senior Investigating Officer in charge of investigating this series. Please read over the subsequent materials and answer the associated questions.**

**Suspect description**

The man responsible for these attacks is estimated to be tall, between 6ft and 6ft 3 inches in height. He speaks with a local accent and with a calm voice. His hair is either brown or dark blonde. He is pale skinned and has a tattoo on his left arm.

**Offence description**

All the victims were walking home from school when the offender who was wearing a hood, or shirt around his face or in one offence dark glasses, grabbed them securely from behind and blindfolded them. The victims were all lead to a secluded spot indicating that the offender has knowledge of the local area. He tells the victims not to make any noise, cry or resist his efforts. He then removes their clothes and demands that they kiss him. He fondles the victim and attempts intercourse. After getting the victim to put their clothing back on he guides them away from the secluded spot, warns them not to look and leaves quietly and calmly.

**Suspect information**

Following the media broadcast of the suspect description; the following individual has been brought to your attention.

**Suspect A** is a 44 year old white male who is 6ft 2 inches tall, has dark blonde hair and has a tattoo on his left arm. Further inquiries have revealed that he is currently single and he is described by local people as insecure with women, although, he has had one previous relationship with a woman which lasted 6 months. He lives alone in an apartment complex half a mile from where the crimes took place and he grew up in the local area, which is reflected, in his accent. He is currently unemployed and inquiries in local pubs reveal that he is a fairly heavy user of alcohol. He was brought up in a poor, working class family and he dropped out of school at 15 before taking his O-levels. Local people described him as having a short temper and a tendency to be quite aggressive. A search of his home revealed that he had a large collection of pornography.

**You should consider this case and decide whether you think the suspect is the offender. Please report your answer below.**

**Please rate, based on the available information, the degree to which Suspect A may be guilty of this series of offences?**

*Please answer by putting a mark on the line below. Put a mark near the left end if you believe the suspect is not guilty at all. Put a mark near the right end of the line if you believe the suspect is completely guilty. Put a mark at an intermediate position if you believe the extent to which the information indicates that the suspect is guilty lies somewhere in between.*

Not at all o-----o-----o-----o-----o-----o-----o-----o-----o-----o Completely

Please rate, based on the available information, the degree to which you feel confident that your judgement is correct?

Please answer by putting a mark on the line below. Put a mark near the left end if you do not feel confident at all that your judgement is correct. Put a mark near the right end of the line if you feel completely confident that your judgement is correct. Put a mark at an intermediate position if your confidence in the correctness of your judgement lies somewhere in between.

Not at all confident o-----o-----o-----o-----o-----o-----o-----o-----o Completely confident

Profile information

Due to the serious nature of this offence, the following offender profile was compiled by a behavioural investigator to assist you in the apprehension of the unknown suspect:

In most crimes of this nature the offender is employed in some form of skilled or office job. The offender will usually be married, often with children of his own. The offender will be sexually exploratory and will probably have had several sexual partners. The offender will own a pornography collection. Most offenders live within 2 miles of the scene of the crime. Many offences of this type do not involve the use of alcohol or drugs. Offenders of this sort are often perceived by others as being quiet, self-assured individuals. Sex offenders of this nature try to avoid police attention and usually have no previous criminal convictions. Offenders typically appear to have normal moral and belief structures. Offences like this are characteristically committed by individuals of approximately 25 years of age (average). Most are aged under 30. This type of sex offender often has superficial charm, and will probably be fairly popular. The offender will probably have been educated beyond the age of 16 and is likely to have gone to university.

Please consider this new information and decide to what extent this should affect your original opinion of whether the suspect is the offender. Please report your answer below.

Please rate again, based on the available information, the degree to which Suspect A may be guilty of this series of offences?

Please answer by putting a mark on the line below. Put a mark near the left end if you believe the suspect is not guilty at all. Put a mark near the right end of the line if you believe the suspect is completely guilty. Put a mark at an intermediate position if you believe the extent to which the information indicates that the suspect is guilty lies somewhere in between.

Not at all o-----o-----o-----o-----o-----o-----o-----o-----o-----o Completely

Please rate, based on the available information, the degree to which you feel confident that your judgement is correct? Please answer by putting a mark on the line below. Put a mark near the left end if you do not feel confident at all that your judgement is correct. Put a mark near the right end of the line if you feel completely confident that your judgement is correct. Put a mark at an intermediate position if your confidence in the correctness of your judgement lies somewhere in between.

Not at all confident o-----o-----o-----o-----o-----o-----o-----o-----o Completely confident

**Please rate how much you felt involved with the case by putting a mark on the line below.**

*Put a mark near the left if you did not feel involved at all and put a mark near the right end of the line if you felt greatly involved with the case. Put a mark at an intermediate position if you believe your involvement with the case lies somewhere in between.*

**No involvement**      0-----0-----0-----0-----0-----0-----0-----0-----0-----0      **Great Involvement**

**Please rate how difficult it was to make a decision by putting a mark on the line below.**

*Put a mark near the left if it was not difficult at all to make a decision and put a mark near the right end of the line if it was really difficult to make a decision. Put a mark at an intermediate position if you believe the difficulty of making a decision lies somewhere in between.*

**Not at all difficult**      0-----0-----0-----0-----0-----0-----0-----0-----0-----0      **Very difficult**

**Participant N.** |\_\_|\_\_|\_\_|

**What is your age?** |\_\_|\_\_|\_\_|

**Please indicate if you are male or female:**

**Male** |\_\_|

**Female** |\_\_|

***For office use only:***

***Time:*** \_\_ : \_\_

***Total time:*** \_\_ : \_\_

## **Appendix A<sub>2</sub>**

### Online Questionnaires

The reduced online English version of the Horne and Ostbery (1976) Morningness-eveningness questionnaire (rH&O, Chelminski et al., 2000)

[https://qtrial.qualtrics.com/SE/?SID=SV\\_bHDSEjH7kHLqFZW](https://qtrial.qualtrics.com/SE/?SID=SV_bHDSEjH7kHLqFZW)



## Appendix A<sub>3</sub>

### Participant Information Sheet

**Study name: An investigation of jury decision-making.**

Dear potential participant,

This is an invitation to participate in a Doctoral Research Project being conducted by Madiha Khan and Rupreet Gurm under the supervision of Dr Gaëlle Villejoubert.

The project aims to examine how jurors make decisions in various circumstances.

Participation in the study involves three stages. The first stage you will be asked to read and complete an online survey containing questions about the time of day when you feel at your best. In the second stage of the experiment, you will be asked to read a brief description of a **criminal case involving a series of sexual assaults against young girls** either on your own or in a small group. You will then be asked to answer a few questions related to the case.

***The questionnaire package should take approximately 20 minutes to complete.***

**Your participation is entirely voluntary. Note that the study involves sensitive material. Should such material cause you discomfort or distress, you may withdraw from participating now, or at any point whilst completing the questionnaire.** All of your answers will remain **confidential and anonymous**. Once data are collected, your results will form part of a larger database, from which only group data will be reported.

Only the researchers, Dr Villejoubert, myself, and Gurm Rupreet will have access to these data. Signing up for this study indicates that you understand the nature of the research and freely consent to participating in the study.

This study has been approved by the Research Ethics Committee of the Department of Psychology, Kingston University. If you have concerns regarding the ethics of this study, please contact the Chair of the Ethics Committee, Prof. François Nectoux, [F.Nectoux@kingston.ac.uk](mailto:F.Nectoux@kingston.ac.uk)

If you have any questions or comment on this study, during or after the completion of the questionnaire, you are encouraged to discuss these at any time by contacting me or my supervisor. Detailed summary of the results will be available towards the end of the year. If you are interested in receiving this information, please contact me for a summary to be posted out.

Thank you for your time and consideration in participating in the present study.

Madiha Khan: [K0801532@kingston.ac.uk](mailto:K0801532@kingston.ac.uk) / Rupreet Gurm: [k0642103@kingston.ac.uk](mailto:k0642103@kingston.ac.uk)

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

**Appendix A<sub>4</sub>****CONSENT FORM****Participant N.** |\_\_|\_\_|\_\_|**Please fill in the form below:-**

- I confirm that I have read and understood the information sheet of invitation for this study. I have been informed of the purpose of taking part.
- I understand what my involvement will entail and any questions have been answered to my satisfaction
- I understand that my participation is entirely voluntary, and that I can withdraw at any time without prejudice.
- I understand that all information obtained will be confidential
- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.
- Contact information has been provided should I wish to seek further information from the investigator at any time for purposes of clarification.

**Signature:** \_\_\_\_\_**Date**    \_\_\_\_/\_\_\_\_/\_\_\_\_**Statement by investigator**

- **I have explained this project and the implications of participation in it to this participant without bias.**
- **I believed that the consent is informed and that he/she understands the implications of participations.**

**Name of investigator** \_\_\_\_\_**Signature** \_\_\_\_\_**Date** \_\_\_\_/\_\_\_\_/\_\_\_\_

Research Supervisor:

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## Appendix A<sub>5</sub>

Participant N. |\_\_|\_\_|\_\_|

### Study Debrief Sheet

The purpose of this study was to find out whether extraneous factors such as whether judgements are made individually or in a group or whether people are making judgements at their most efficient time of the day would influence individuals' perception of a suspect's guilt.

The content of the experiment contained a description of a sexual crime against children. If the content and nature of the experiment has caused you to feel discomfort or stress, or you have been affected in any way, you can call Victim Support on 0845 30 30 900, or alternatively go to [www.victimsupport.org.uk](http://www.victimsupport.org.uk) or [www.samaritans.org](http://www.samaritans.org) to receive the help or support you may require.

All data provided by all participants will remain confidential. However you have the right to withdraw your data at any time of the investigation. To do this please contact the email address provided and state your participation number which is at the top of this page. If there are any further questions regarding the study, please also contact us via the email addresses provided.

Thank you again for your participation.

Researchers:

Madiha Khan: [K0801532@kingston.ac.uk](mailto:K0801532@kingston.ac.uk)

Rupreet Gurm: [K0642103@kingston.ac.uk](mailto:K0642103@kingston.ac.uk)

Supervisor:

Gaëlle Villejoubert

[g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## **Appendix B<sub>1</sub>**

### Questionnaires

*Please take your time to read this information carefully.*

#### **Incident information**

The following considers a series of reports of sexual assaults between April and July 2011. All evidence and information relating to this series has been reviewed.

Psychological interviews were carried out with the three victims. The first, assaulted on 10th April was 11 years old. The second, a 12-year-old victim, was assaulted May 22nd. The third was a 10- year-old girl who was assaulted on the 5th of July.

The following description of the suspect and of the offence have been established on the basis of the information collected in the interviews.

#### ***Suspect description***

The man responsible for these attacks is estimated to be tall, between 6ft and 6ft 3 inches in height. He speaks with a local accent and with a calm voice. His hair is either brown or dark blonde. He is pale skinned and has a tattoo on his left arm.

#### ***Offence description***

All the victims were walking home from school when the offender who was wearing a hood, or shirt around his face or in one offence dark glasses, grabbed them securely from behind and blindfolded them. The victims were all lead to a secluded spot indicating that the offender has knowledge of the local area. He tells the victims not to make any noise, cry or resist his efforts. He then removes their clothes and demands that they kiss him. He fondles the victim and attempts intercourse. After getting the victim to put their clothing back on he guides them away from the secluded spot, warns them not to look and leaves quietly and calmly.

Following the media broadcast of the suspect description; the following individual has been brought to your attention.

*Suspect information*

**Suspect A** is a 44 year old white male who is 6ft 2 inches tall, has dark blonde hair and has a tattoo on his left arm. Further inquiries have revealed that he is currently single and he is described by local people as insecure with women, although, he has had one previous relationship with a woman which lasted 6 months. He lives alone in an apartment complex half a mile from where the crimes took place and he grew up in the local area, which is reflected, in his accent. He is currently unemployed and inquiries in local pubs reveal that he is a fairly heavy user of alcohol. He was brought up in a poor, working class family and he dropped out of school at 15 before taking his O-levels. Local people described him as having a short temper and a tendency to be quite aggressive. A search of his home revealed that he had a large collection of pornography.

*Please take your time to read this information carefully.*

### **Profile information**

Due to the serious nature of this offence, you requested a behavioural investigator to assist you in the apprehension of the unknown offender. He produced the following offender profile.

#### *Offender profile*

In most crimes of this nature the offender is employed in some form of skilled or office job. The offender will usually be married, often with children of his own. The offender will be sexually exploratory and will probably have had several sexual partners. The offender will own a pornography collection. Most offenders live within 2 miles of the scene of the crime. Many offences of this type do not involve the use of alcohol or drugs. Offenders of this sort are often perceived by others as being quiet, self-assured individuals. Sex offenders of this nature try to avoid police attention and usually have no previous criminal convictions. Offenders typically appear to have normal moral and belief structures. Offences like this are characteristically committed by individuals of approximately 25 years of age (average). Most are aged under 30. This type of sex offender often has superficial charm, and will probably be fairly popular. The offender will probably have been educated beyond the age of 16 and is likely to have gone to university.

## Questionnaire

**Reminder.** This study aims to explore investigative decision-making. It involves a series of sexual assaults against young girls. Should such material cause you discomfort or distress, you are not obliged to respond to the questionnaire and can leave the questionnaire at any time.

Before we begin, please answer the following questions:

1. What is your participant number? |\_|\_|\_|\_|

2. What was your MEQ score? |\_|\_|

3. Do you feel mentally alert right now?

*Please put a mark on the line below to provide your answer. Put your mark near the left end if you feel mentally tired and do not feel mentally alert at all. Put a mark near the right end of the line if you feel wide awake and extremely alert mentally.*

Not at all ○-----○-----○-----○-----○-----○-----○-----○-----○-----○ Extremely

4. What time is it now? |\_|\_| : |\_|\_|

Imagine that you are acting as the Senior Investigating Officer in charge of investigating a series of sexual assaults against young girls. Please read over the subsequent materials in the order presented.

**Please read the “incident information” laminate now.**

### Decision task

You should consider this case and decide whether you think the suspect is the offender. Please report your answer below.

5. Based on the available information, please rate the probability that Suspect A may have committed this series of offences.

*Please answer by putting a mark on the line below. Put your mark near the left end if you believe it is absolutely impossible that Suspect A committed the offences. Put a mark near the right end of the line if you believe it is certain that Suspect A has committed the offences. Put a mark at an intermediate position if you believe the probability that Suspect A committed the offences lies somewhere in between.*

Impossible ○-----○-----○-----○-----○-----○-----○-----○-----○-----○ Certain

6. Please rate the degree to which you feel confident that your judgment is correct?

*Please answer by putting a mark on the line below.*

Not at all confident 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Absolutely confident

7. Please provide up to 5 possible reasons explaining why Suspect A may NOT actually be the offender.

a.....

b.....

c.....

d.....

e.....

**Please read the “profile information” laminate now.**

**Decision task (continued)**

8. Based on all the information now at your disposal, please rate again the probability that Suspect A may have committed this series of offences.

*Please answer by putting a mark on the line below.*

Impossible 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Certain

9. Please rate the degree to which you now feel confident that your judgment is correct?

*Please answer by putting a mark on the line below.*

Not at all confident 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Absolutely confident

---



**Thank you for your answers. To better understand how you completed the task, we would be grateful if you could answer the following questions:**

10. What time is it now? |\_|\_| : |\_|\_|

11. To what extent did you feel involved with the case?

*Please answer by putting a mark on the line below.*

Not at all involved o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely involved

12. To what extent did you find it difficult to list 5 reasons explaining why Suspect A might NOT have been the offender?

*Please answer by putting a mark on the line below.*

Not at all difficult o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely difficult

13. To what extent did you find it difficult to estimate the probability that Suspect A might have been the offender?

*Please answer by putting a mark on the line below.*

Not at all difficult o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely difficult

14. What is your age? |\_|\_|\_|\_|

15. Are you are male or female? Male |\_|\_| Female |\_|\_|

16. What is your main area of study? (e.g., psychology, engineering, journalism, business, etc.)

.....

17. What is your level of study? (e.g., First year, Second year, Final year, Master, PhD, etc.)

.....

**Thank you for taking part in this study!**

## Questionnaire

**Reminder.** This study aims to explore investigative decision-making. It involves a series of sexual assaults against young girls. Should such material cause you discomfort or distress, you are not obliged to respond to the questionnaire and can leave the questionnaire at any time.

Before we begin, please answer the following questions:

1. What is your participant number? |\_|\_|\_|\_|

2. What was your MEQ score? |\_|\_|\_|

3. Do you feel mentally alert right now?

*Please put a mark on the line below to provide your answer. Put your mark near the left end if you feel mentally tired and do not feel mentally alert at all. Put a mark near the right end of the line if you feel wide awake and extremely alert mentally.*

Not at all o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely

4. What time is it now? |\_|\_|\_| : |\_|\_|\_|

Imagine that you are acting as the Senior Investigating Officer in charge of investigating a series of sexual assaults against young girls. Please read over the subsequent materials in the order presented.

**Please read the “incident information” laminate now.**

### Decision task

You should consider this case and decide whether you think the suspect is the offender. Please report your answer below.

5. Based on the available information, please rate the probability that Suspect A may have committed this series of offences.

*Please answer by putting a mark on the line below. Put your mark near the left end if you believe it is absolutely impossible that Suspect A committed the offences. Put a mark near the right end of the line if you believe it is certain that Suspect A has committed the offences. Put a mark at an intermediate position if you believe the probability that Suspect A committed the offences lies somewhere in between.*

Impossible o-----o-----o-----o-----o-----o-----o-----o-----o-----o Certain

6. Please rate the degree to which you feel confident that your judgment is correct?

*Please answer by putting a mark on the line below.*

Not at all confident 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Absolutely confident

7. Please provide up to 5 possible reasons explaining why Suspect A may actually be the offender.

a.....

b.....

c.....

d.....

e.....

**Please read the “profile information” laminate now.**

**Decision task (continued)**

8. Based on all the information now at your disposal, please rate again the probability that Suspect A may have committed this series of offences.

*Please answer by putting a mark on the line below.*

Impossible 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Certain

9. Please rate the degree to which you now feel confident that your judgment is correct?

*Please answer by putting a mark on the line below.*

Not at all confident 0-----0-----0-----0-----0-----0-----0-----0-----0-----0 Absolutely confident

---

**Thank you for your answers. To better understand how you completed the task, we would be grateful if you could answer the following questions:**

10. What time is it now? |\_|\_| : |\_|\_|

11. To what extent did you feel involved with the case?

*Please answer by putting a mark on the line below.*

Not at all involved o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely involved

12. To what extent did you find it difficult to list 5 reasons explaining why Suspect A might NOT have been the offender?

*Please answer by putting a mark on the line below.*

Not at all difficult o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely difficult

13. To what extent did you find it difficult to estimate the probability that Suspect A might have been the offender?

*Please answer by putting a mark on the line below.*

Not at all difficult o-----o-----o-----o-----o-----o-----o-----o-----o-----o Extremely difficult

14. What is your age? |\_|\_|\_|\_|

15. Are you are male or female? Male |\_|\_| Female |\_|\_|

16. What is your main area of study? (e.g., psychology, engineering, journalism, business, etc.)

.....

17. What is your level of study? (e.g., First year, Second year, Final year, Master, PhD, etc.)

.....

**Thank you for taking part in this study!**

## Appendix B<sub>2</sub>

### Online Questionnaires

The reduced online English version of the Horne and Ostbery (1976) Morningness-eveningness questionnaire (rH&O, Chelminski et al., 2000)

#### MEQ Questionnaire

Q1 Please write down your email address so that we can contact you for the next part of the study. (You may withdraw from participating now, or at any point whilst completing the questionnaire. If the results of the study are published, then your answers will not be identifiable)

Q2 Considering only your own “feeling best” rhythm, at what time would you get up if you were entirely free to plan your day?

Q3 During the first half-hour of having woken in the morning, how tired do you feel?

- Very tired (1)
- Fairly tired (2)
- Fairly refreshed (3)
- Very refreshed (4)

Q4 At what time in the evening do you feel tired and as a result in need of sleep?

Q5 At what time of the day do you think that you reach your “feeling best” peak?

Q6 One hears of “morning” and “evening” types of people. Which one of these types do you consider yourself to be?

- Definitely a “morning” type (1)
- Rather more a “morning” than an “evening” type (2)
- Rather more an “evening” than a “morning” type (3)
- Definitely an “evening type” (4)

## Appendix B<sub>3</sub>

### Participant Information Sheet

**Study name: An investigation of Belief Perseverance.**

Dear potential participant,

This is an invitation to participate in a Doctoral Research Project being conducted by Madiha Khan under the supervision of Dr Gaëlle Villejoubert.

The project aims to examine how belief perseverance occurs and how individual make decisions in various circumstances.

Participation in the study involves three stages. The first stage you will be asked to read and complete the questionnaire containing questions about the time of day when you feel at your best. In the second stage of the experiment, you will be asked to read a brief description of a **criminal case involving a series of sexual assaults against young girls**. You will then be asked to answer a few questions related to the case.

*The questionnaire package should take approximately 20 minutes to complete.*

**Your participation is entirely voluntary. Note that the study involves sensitive material. Should such material cause you discomfort or distress, you may withdraw from participating now, or at any point whilst completing the questionnaire.** All of your answers will remain **confidential and anonymous**. Once data are collected, your results will form part of a larger database, from which only group data will be reported. Only the researchers, Dr. Villejoubert and I will have access to these data. Signing up for this study indicates that you understand the nature of the research and freely consent to participating in the study.

This study has been approved by the Research Ethics Committee of the Department of Psychology, Kingston University. If you have concerns regarding the ethics of this study, please contact the Chair of the Ethics Committee, Prof. François Nectoux, [F.Nectoux@kingston.ac.uk](mailto:F.Nectoux@kingston.ac.uk)

If you have any questions or comment on this study, during or after the completion of the questionnaire, you are encouraged to discuss these at any time by contacting me or my supervisor. Detailed summary of the results will be available towards the end of the year. If you are interested in receiving this information, please contact me for a summary to be posted out.

Thank you for your time and consideration in participating in the present study.

Madiha Khan: [K0801532@kingston.ac.uk](mailto:K0801532@kingston.ac.uk)

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## Appendix B<sub>4</sub>

### CONSENT FORM

Participant N. |\_\_|\_\_|\_\_|

**Please fill in the form below:-**

- I confirm that I have read and understood the information sheet of invitation for this study. I have been informed of the purpose of taking part.
- I understand what my involvement will entail and any questions have been answered to my satisfaction
- I understand that my participation is entirely voluntary, and that I can withdraw at any time without prejudice.
- I understand that all information obtained will be confidential
- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.
- Contact information has been provided should I wish to seek further information from the investigator at any time for purposes of clarification.

**Signature:** \_\_\_\_\_

**Date**      \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_

#### Statement by investigator

- **I have explained this project and the implications of participation in it to this participant without bias.**
- **I believed that the consent is informed and that he/she understands the implications of participations.**

**Name of investigator** \_\_\_\_\_

**Signature** \_\_\_\_\_

**Date** \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_

Research Supervisor:

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## Appendix B<sub>5</sub>

Participant N. |\_\_|\_\_|\_\_|

### Study Debrief Sheet

The purpose of this study was to find out whether extraneous factors such as whether decision and judgements are made when they are generating explanation in a narrative form or in a listing form or whether people are making decision and judgements at their most efficient time of the day would influence individuals' belief perseverance of a suspect's guilt.

The content of the experiment contained a description of a sexual crime against children. If the content and nature of the experiment has caused you to feel discomfort or stress, or you have been affected in any way, you can call Victim Support on 0845 30 30 900, or alternatively go to [www.victimsupport.org.uk](http://www.victimsupport.org.uk) or [www.samaritans.org](http://www.samaritans.org) to receive the help or support you may require.

All data provided by all participants will remain confidential. However you have the right to withdraw your data at any time of the investigation. To do this please contact the email address provided and state your participation number which is at the top of this page. If there are any further questions regarding the study, please also contact us via the email addresses provided.

Thank you again for your participation.

Researchers:

Madiha Khan: [K0801532@kingston.ac.uk](mailto:K0801532@kingston.ac.uk)

Supervisor:

Gaëlle Villejoubert

[g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)



### Appendix C<sub>1</sub>

*For office use only:*

Time Started: \_\_: \_\_

Total time: \_\_: \_\_

### Questionnaire

1. What is your participant number? |\_|\_|\_|\_|

2. What was your MEQ score? |\_|\_|

3. Do you feel mentally alert right now?

*Please put a mark on the line below to provide your answer. Put your mark near the left end if you feel mentally tired and do not feel mentally alert at all. Put a mark near the right end of the line if you feel wide-awake and extremely alert mentally.*

Not at all    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Extremely

***The following section includes a number of situations in which you are asked to make a decision. Please take your time to read each individual situation carefully, and choose the option which you prefer. There are no right or wrong answers.***



The National Cancer Institute has two possible treatments for lung cancer, which could become standard treatments across the country. Assume that the exact scientific estimates of the consequences of the treatments are as follows:

**Treatment A:** Of every 1000 people who get lung cancer, 400 will be saved.

**Treatment B:** 2/5 chance that 1000 of every 1000 who get lung cancer will be saved and 3/5 chance that no people of every 1000 who get lung cancer will be saved.

### Decision task

**Based on the available information, please rate the extent to which you prefer Treatment A or Treatment B.**

1. *Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Treatment A over Treatment B. Put a mark near the right end of the line if you definitely prefer Treatment B. Put a mark at an intermediate position if your preference for Treatment A or Treatment B lies somewhere in between.*

Treatment A    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Treatment B

**Please rate the degree to which you feel confident that your judgement is correct?**

2. *Please answer by putting a mark on the line below.*

Not at all confident    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Absolutely confident

The United States is expecting the outbreak of a new strain of HIV virus which is expected to kill 2000 persons. Two alternative programs were developed to combat the disease. Assume that the exact scientific estimates of the consequences of the programs are as follows:

**Program A:** 800 people will be saved.

**Program B:** 2/5 probability that 2000 people will be saved and 3/5 probability that no people will be saved.

### Decision task

**Based on the available information, please rate the extent to which you prefer Program A or Program B.**

1. *Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Program A over Program B. Put a mark near the right end of the line if you definitely prefer Program B. Put a mark at an intermediate position if your preference for Program A or Program B lies somewhere in between.*

Program A    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Program B

**Please rate the degree to which you feel confident that your judgement is correct?**

2. *Please answer by putting a mark on the line below.*

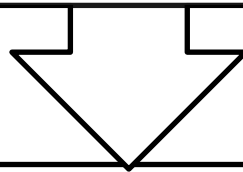
Not at all confident    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Absolutely confident

### Some Questions

*We would be delighted if you could answer a few additional questions. The answers will take a few minutes only.*

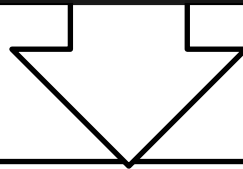
**A bat and a ball cost \$1.10 in total. the bat cost \$1.00 more than the ball.  
how much does the ball costs**

----- cents?



**If it takes 5 machine4s to make 5 widgets, how long would it take 100  
machines to make 100 widgets?**

----- minutes



**in a lake, there is patch of lily pads. Everyday the patch doubles in size. if it  
takes 48 days for the patch to cover the entire lake, how long would it take  
for the patch to cover half of the lake?**

----- days?



The National Cancer Institute has two possible treatments for lung cancer, which could become standard treatments across the country. Assume that the exact scientific estimates of the consequences of the treatments are as follows:

**Treatment A:** Of every 1000 people who get lung cancer, 600 will die.

**Treatment B:** 2/5 chance that no people of every 1000 who get lung cancer will die and 3/5 chance that 1000 people of every 1000 who get lung cancer will die.

**Decision task**

**Based on the available information, please rate the extent to which you prefer Treatment A or Treatment B.**

1. *Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Treatment A over Treatment B. Put a mark near the right end of the line if you definitely prefer Treatment B. Put a mark at an intermediate position if your preference for Treatment A or Treatment B lies somewhere in between.*

Treatment A    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Treatment B

**Please rate the degree to which you feel confident that your judgement is correct?**

2. *Please answer by putting a mark on the line below.*

Not at all confident    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Absolutely confident

The United States is expecting the outbreak of a new strain of HIV virus which is expected to kill 2000 persons. Two alternative programs were developed to combat the disease. Assume that the exact scientific estimates of the consequences of the programs are as follows:

**Program A:** 1200 people will die.

**Program B:** 2/5 probability that nobody will die and 3/5 probability that 2000 people will die.

**Decision task**

**Based on the available information, please rate the extent to which you prefer Program A or Program B.**

- Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Program A over Program B. Put a mark near the right end of the line if you definitely prefer Program B. Put a mark at an intermediate position if your preference for Program A or Program B lies somewhere in between.*

**Program A**    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    **Program B**

**Please rate the degree to which you feel confident that your judgement is correct?**

- Please answer by putting a mark on the line below.*

**Not at all confident**    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    **Absolutely confident**

**Thank you for your answers. To better understand how you completed the task, we would be grateful if you could answer the following questions:**

- To what extent did you feel involved with the task?  
*Please answer by putting a mark on the line below.*

**Not at all involved**    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    **Extremely involved**

- What is your age? |\_\_|\_\_|
- Are you are male or female? Male |\_\_| Female |\_\_|
- What is your main area of study? (e.g., psychology, engineering, journalism, business, etc.)  
.....
- What is your level of study? (e.g., First year, Second year, Final year, Master, PhD, etc.)  
.....

**Thank you for taking part in this study!**

*For office use only:*

*Time Finished: \_\_: \_\_*



For office use only:

Time Started: \_\_: \_\_

Total time: \_\_: \_\_

### Questionnaire

1. What is your participant number? |\_|\_|\_|\_|

2. What was your MEQ score? |\_|\_|

3. Do you feel mentally alert right now?

*Please put a mark on the line below to provide your answer. Put your mark near the left end if you feel mentally tired and do not feel mentally alert at all. Put a mark near the right end of the line if you feel wide-awake and extremely alert mentally.*

Not at all    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Extremely

***The following section includes a number of situations in which you are asked to make a decision. Please take your time to read each individual situation carefully, and choose the option which you prefer. There are no right or wrong answers.***



The National Cancer Institute has two possible treatments for lung cancer, which could become standard treatments across the country. Assume that the exact scientific estimates of the consequences of the treatments are as follows:

**Treatment A:** Of every 1000 people who get lung cancer, 600 will die.

**Treatment B:** 2/5 chance that no people of every 1000 who get lung cancer will die and 3/5 chance that 1000 people of every 1000 who get lung cancer will die.

**Decision task**

**Based on the available information, please rate the extent to which you prefer Treatment A or Treatment B.**

- Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Treatment A over Treatment B. Put a mark near the right end of the line if you definitely prefer Treatment B. Put a mark at an intermediate position if your preference for Treatment A or Treatment B lies somewhere in between.*

Treatment A    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Treatment B

**Please rate the degree to which you feel confident that your judgement is correct?**

- Please answer by putting a mark on the line below.*

Not at all confident    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Absolutely confident

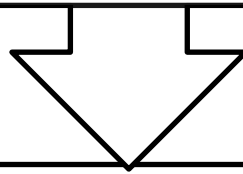


### Some Questions

*We would be delighted if you could answer a few additional questions. The answers will take a few minutes only.*

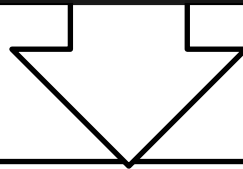
**A bat and a ball cost \$1.10 in total. the bat cost \$1.00 more than the ball.  
how much does the ball costs**

----- cents?



**If it takes 5 machine4s to make 5 widgets, how long would it take 100  
machines to make 100 widgets?**

----- minutes



**in a lake, there is patch of lily pads. Everyday the patch doubles in size. if it  
takes 48 days for the patch to cover the entire lake, how long would it take  
for the patch to cover half of the lake?**

----- days?



The National Cancer Institute has two possible treatments for lung cancer, which could become standard treatments across the country. Assume that the exact scientific estimates of the consequences of the treatments are as follows:

**Treatment A:** Of every 1000 people who get lung cancer, 400 will be saved.

**Treatment B:** 2/5 chance that 1000 of every 1000 who get lung cancer will be saved and 3/5 chance that no people of every 1000 who get lung cancer will be saved.

**Decision task**

**Based on the available information, please rate the extent to which you prefer Treatment A or Treatment B.**

3. *Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Treatment A over Treatment B. Put a mark near the right end of the line if you definitely prefer Treatment B. Put a mark at an intermediate position if your preference for Treatment A or Treatment B lies somewhere in between.*

Treatment A    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Treatment B

**Please rate the degree to which you feel confident that your judgement is correct?**

4. *Please answer by putting a mark on the line below.*

Not at all confident    o-----o-----o-----o-----o-----o-----o-----o-----o-----o    Absolutely confident

The United States is expecting the outbreak of a new strain of HIV virus which is expected to kill 2000 persons. Two alternative programs were developed to combat the disease. Assume that the exact scientific estimates of the consequences of the programs are as follows:

**Program A:** 800 people will be saved.

**Program B:** 2/5 probability that 2000 people will be saved and 3/5 probability that no people will be saved.

**Decision task**

**Based on the available information, please rate the extent to which you prefer Program A or Program B.**

- 3. *Please answer by putting a mark on the line below. Put your mark near the left end if you definitely prefer Program A over Program B. Put a mark near the right end of the line if you definitely prefer Program B. Put a mark at an intermediate position if your preference for Program A or Program B lies somewhere in between.*

Program A    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Program B

**Please rate the degree to which you feel confident that your judgement is correct?**

- 4. *Please answer by putting a mark on the line below.*

Not at all confident    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Absolutely confident

**Thank you for your answers. To better understand how you completed the task, we would be grateful if you could answer the following questions:**

- 1. To what extent did you feel involved with the task?  
*Please answer by putting a mark on the line below.*

Not at all involved    0-----0-----0-----0-----0-----0-----0-----0-----0-----0    Extremely involved

2. What is your age? |\_\_|\_\_|

3. Are you are male or female? Male |\_\_| Female |\_\_|

4. What is your main area of study? (e.g., psychology, engineering, journalism, business, etc.)

.....

5. What is your level of study? (e.g., First year, Second year, Final year, Master, PhD, etc.)

.....

**Thank you for taking part in this study!**

*For office use only:*

*Time Finished: \_\_: \_\_*



## Appendix C<sub>2</sub>

The reduced online English version of the Horne and Ostbery (1976) Morningness-eveningness questionnaire (rH&O, Chelminski et al., 2000)

### MEQ Questionnaire

Q1) Considering only your own “feeling best” rhythm, at what time would you get up if you were entirely free to plan your day?

Q2) During the first half-hour of having woken in the morning, how tired do you feel?

- Very tired
- Fairly tired
- Fairly refreshed
- Very refreshed

Q3) At what time in the evening do you feel tired and as a result in need of sleep?

Q4) At what time of the day do you think that you reach your “feeling best” peak?

Q5) One hears of “morning” and “evening” types of people. Which one of these types do you consider yourself to be?

- Definitely a “morning” type
- Rather more a “morning” than an “evening” type
- Rather more an “evening” than a “morning” type
- Definitely an “evening type”

## Appendix C<sub>3</sub>

### Participant Information Sheet

**Study name: An investigation of framing effects.**

Dear potential participant,

This is an invitation to participate in a Doctoral Research Project being conducted by Madiha Khan under the supervision of Dr Gaëlle Villejoubert.

The project aims to examine how framing effect occurs and how individual make decisions in various circumstances.

Participation in the study involves three stages. The first stage you will be asked to read and complete the questionnaire containing questions about the time of day when you feel at your best. In the second stage of the experiment, you will be asked to make a choice in a simple task. You will then be asked to answer a few questions related to the task.

***The questionnaire package should take approximately 20 minutes to complete.***

**Your participation is entirely voluntary.** All of your answers will remain **confidential and anonymous**. Once data are collected, your results will form part of a larger database, from which only group data will be reported. Only the researchers, Dr. Villejoubert and I will have access to these data. Signing up for this study indicates that you understand the nature of the research and freely consent to participating in the study.

This study has been approved by the Research Ethics Committee of the Department of Psychology, Kingston University. If you have concerns regarding the ethics of this study, please contact the Chair of the Ethics Committee, Prof. François Nectoux, [F.Nectoux@kingston.ac.uk](mailto:F.Nectoux@kingston.ac.uk)

If you have any questions or comment on this study, during or after the completion of the questionnaire, you are encouraged to discuss these at any time by contacting me or my supervisor. Detailed summary of the results will be available towards the end of the year. If you are interested in receiving this information, please contact me for a summary to be posted out.

Thank you for your time and consideration in participating in the present study.

Madiha Khan: [KU48114@Kingston.ac.uk](mailto:KU48114@Kingston.ac.uk)

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## Appendix C<sub>4</sub>

### CONSENT FORM

Participant N. |\_\_|\_\_|\_\_|

Please fill in the form below:-

- I confirm that I have read and understood the information sheet of invitation for this study. I have been informed of the purpose of taking part.
- I understand what my involvement will entail and any questions have been answered to my satisfaction
- I understand that my participation is entirely voluntary, and that I can withdraw at any time without prejudice.
- I understand that all information obtained will be confidential
- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.
- Contact information has been provided should I wish to seek further information from the investigator at any time for purposes of clarification.

Signature: \_\_\_\_\_

Date      \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_

Research Supervisor:

Dr Gaëlle Villejoubert: [g.villejoubert@kingston.ac.uk](mailto:g.villejoubert@kingston.ac.uk)

## Appendix C<sub>5</sub>

Participant N. |\_\_|\_\_|\_\_|

### Study Debrief Sheet

The purpose of this study was to find out whether framing effects would be stronger during circadian congruent times and relatively weaker during incongruent times.

All data provided by all participants will remain confidential. However you have the right to withdraw your data at any time of the investigation. To do this please contact the email address provided and state your participation number which is at the top of this page. If there are any further questions regarding the study, please also contact us via the email addresses provided.

Thank you again for your participation.

Researchers:

Madiha Khan: KU48114@Kingston.ac.uk

Supervisor:

Gaëlle Villejoubert

g.villejoubert@kingston.ac.uk