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The Role of Incidental Emotion in Cognitive Processing

- an integrative approach -

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Content

Abstract

With a between-subjects experimental design, the present study examined effects of incidental emotions on cognitive processing in a subsequent decision-making task. Rather than taking a purely valence-based approach, this study investigated different aspects of emotional experience and its effects on cognitive processing. Findings suggested that aspects other than incidental valence are indeed important. As predicted, incidental arousal was negatively related to analytic processing and positively related to intuitive processing. Both perceived and physiological arousal were significant in explaining cognitive processing, whereas perceived valence was insignificant in all models. Findings also indicated a significant effect of certainty appraisals on analytic processing, but in opposite directions than predicted. A nearly significant interaction effect between physiological arousal and anticipated effort appraisals was also observed for analytic processing. Overall, findings imply that studies may benefit from going beyond valence when investigating emotion and its effects on cognitive processing. Theoretical, methodological, and practical implications are discussed.

1. Introduction

A profound interest in the interplay between emotion and thinking has emerged within the judgment and decision-making (JDM) field, as scholars have come to realise that our judgments and decisions are not based on "cold" cognitive processes alone. According to Schwarz and Clore (2007), the "hot" aspects of our thinking were rediscovered in the 1980s after having been neglected for a long time. Now, decades later, the notion that emotions influence judgments and decisions is no longer a controversial argument. Our emotions work as sources of information, through affective, bodily, and cognitive experiences. These sources are informative regarding our current situation, and we adopt our cognitive processing strategy to match our perceptions of situational requirements (Schwarz, 2002).

Emotions differ from other affective states (e.g., moods) by having "an identifiable referent, a sharp rise in time, limited duration, and often high intensity" (Schwarz & Clore, 2007, p. 385). Thus, their effects are relatively short-lived. An important assumption underlying the present study is the existence of incidental emotions. Unlike *integral emotions*, which arise from the judgment or choice at hand (Damasio, 1994), *incidental emotions* are not related to the current situation, but "pervasively carry over from one situation to the next, affecting decisions that should, from a normative perspective, be unrelated to that emotion" (Blanchette & Richards, 2010, p. 803). This carryover process implies that an emotion triggered in one situation automatically elicits a motive to act on this emotion towards targets unrelated to the source of the emotion. Whereas effects of integral emotions can operate at both conscious and unconscious levels, effects of incidental emotions typically occur without our awareness (Lerner, Li, Valdesolo, & Kassam, 2015). Incidental emotions influence our reasoning processes, and "have a variety of rational and irrational influences on judgements, decisions, and behaviours" (Pham, 2007, p. 157). For example, a manager may receive an emotionally provoking phone call before meeting with a job candidate. The emotion caused by the phone call (e.g., anger) is incidental if it carries over to the next situation and affects the manager's selection decision.

Research has repeatedly shown that incidental emotions influence how individuals process information (for reviews, see for example (Schwarz & Clore, 2007)). However, findings have been inconsistent and underlying mechanisms are not clear. An important question relates to the definition of emotion, with consequences for how we understand its effects. Most emotion theories define emotions along the dimensions of both valence and arousal (i.e., core affect) (e.g., Russell, 2003), whereas most studies in the JDM field implicitly or explicitly have taken a valence-based approach (Lerner, et al., 2015), thus focusing on emotions as predominantly positive or negative. Recently, the field has begun to realise that valence may not be sufficient to fully explain the influence emotions have on judgments and decisions. Recent developments include both the (re) introduction of arousal (Blanchette & Richards, 2010), as well as explorations into other aspects of emotion, such as the cognitive (Lerner, et al., 2015). One representative of the latter is the appraisal-tendency framework (Lerner & Keltner, 2000) arguing that incidental emotions influence cognitive processing through how people *appraise* the decision-making situation.

The purpose of this study is to expand our understanding of the influence of incidental emotions on cognitive processing by going beyond a simple valence-based approach in three ways. First, we challenge the valence-based approach by treating valence and arousal as equals, and investigate whether *arousal* is more important than valence for cognitive processing. Second, we include important aspects of *cognitive appraisals,* and investigate whether these add to our understanding beyond valence and arousal. Third, in an attempt to *integrate* different perspectives, we explore whether and how arousal moderates the influence of cognitive appraisals.

2. Theoretical Framework and Hypotheses

Within literature on cognitive processing, dual-process theories dominate the discussion (e.g., Epstein, 1994; Kahneman, 2003; Mukherjee, 2010; Stanovich & West, 2000). Such theories distinguish between two basic ways individuals process information. The first, an *intuitive processing mode,* is quick and spontaneous and associated with heuristic and effortless decision-making, whereas the second, an *analytic processing mode,* is slow and deliberate and associated with systematic and careful analysis. The intuitive mode makes relatively low cognitive demands, as opposed to the analytic mode, which makes high demands on cognitive capacity and requires high mental effort. We treat cognitive processing as a two-dimensional construct with separate dimensions of intuition and analysis, and argue that "both systems operate in parallel and compete for control of cognition and behaviour" (Bakken, Haerem, Hodgkinson, & Sinclair, 2016, p. 4). This is in contrast to viewing intuitive processing as the norm; the analytic processing mode only intervenes to correct this norm (e.g., Kahneman, 2003).

In the section below, we outline different theoretical perspectives on the structure and influence of incidental emotions on cognitive processing.

2.1. Core Affect

Russell (2003) defines core affect as "a neurophysiological state that is consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values" (p. 147). The definition builds on the circumplex model of affect (Russell, 1980), and proposes that all affective states are the product of these two independent systems (Posner, Russell, & Peterson, 2005). In the valence dimension, emotion is the assessment of one's current condition, and its value can be positive or negative. In the arousal dimension, emotion is one's sense of energy and mobilisation, and its values can be high or low. Each emotion can be understood as a combination of these dimensions, or as "varying degrees of both valence and arousal" (Posner, et al., 2005, p. 715)

Despite the inclusion of both valence and arousal in most *definitions*, most *studies* have taken a purely valence-based approach (Forgas, 1995). The focus on valence is prevalent across studies of both mood and emotion (Schwarz & Clore, 2007). Confusingly, researchers are often not consistent in their definition and manipulation of affective states. For example, some studies using mood as the affective label are capturing relatively short-lived effects of emotion in an experimental setting, rather than more enduring characteristics of mood (e.g., Baron, 1987; Bless, Bohner, Schwarz, & Strack, 1990; Bless, Clore, Golisano, Rabel, & Schwarz, 1996; Mackie & Worth, 1989). Consequently, a consistent discussion about the role of valence in the relationship between *emotion* and cognitive processing may not be feasible. Nevertheless, consistent across studies is an emphasis on the influence of *valence* on cognitive processing. The discussion below will include studies manipulating valence in laboratory settings.

2.1.1. Valence or Arousal?

A large body of research has documented the effect of valence on cognitive processing (e.g., Forgas, 1995; Schwarz & Clore, 2007). The process of *affect infusion* is widely used to explain this influence (Forgas, 1995). Affect infusion involves "the process whereby affectively loaded information exerts an influence on and becomes incorporated into the judgemental process, entering into the judge's deliberations and eventually colouring the judgemental outcome" (Forgas, 1995, p. 39). Through affect infusion, valence informs us about the nature of the situation, with consequences for cognitive processing (Forgas, 1995). *Negative* valence signals that the situation is problematic and threatening, requiring the individual to process information more carefully, thereby fostering analytic processing (e.g., Bless, et al., 1996; Fiedler, 2001; Schwarz, 1990, 2000). Subjects in negatively valenced conditions have been found to rely less on heuristics (R. C. Sinclair, 1988), and retrieve more information and work longer on a problem (Barth & Funke, 2010). In contrast, *positive* valence does not signal the same threat or problems, leading individuals to attend more to pre-existing knowledge and routines (Bless et al., 1996), triggering intuitive processing (Batra & Stayman, 1990; Schwarz & Clore, 1983).

Despite the vast amount of studies relating negative valence to analytic processing and positive valence to intuitive processing (for a review, see Schwarz & Clore, 2007), empirical findings are not entirely consistent. Isen and colleagues have fronted the counterpart of the discussion, arguing that positive valence may actually give access to alternative cognitive perspectives, making it easier for people to see interconnections between different ideas and process material in a more flexible and integrated way (Isen, Johnson, Mertz, & Robinson, 1985; Isen & Means, 1983). Attempts to clarify these contradicting findings include Oaksford, Morris, Grainger, and Williams (1996) suggesting positive valence suppresses performance in convergent, analytic tasks, while facilitates performance in divergent, creative tasks. Thus, whereas positive valence may relate to other beneficial outcomes, such as creativity, negative valence may enhance performance on tasks requiring a systematic and analytic approach (Forgas, 2007).

At first glance, the relationship between valence and cognitive processing might seem straightforward. However, a closer inspection of these studies make us question whether these effects are actually due to valence, as differences in *arousal* are often not taken into account (e.g., Baron, 1987; Bless, et al., 1990; Bless, et al., 1996; Mackie & Worth, 1989; Semmler & Brewer, 2002; R. C. Sinclair, 1988). Frequently, studies have investigated effects of valence by comparing subjects induced to feel happiness, often characterised by high arousal

(Russell, 2003), with subjects in sad (e.g., Bless, et al., 1990; Oaksford, et al., 1996) or neutral (e.g., Bless, et al., 1996; Mackie & Worth, 1989) conditions, both characterized by low arousal. Thus, happy subjects are often presented with more arousing stimuli than their counterparts, and effects of positive valence could just as easily be attributed to effects of high arousal in these studies.

Support for the effect of arousal can be drawn from studies contradicting the valence-based approach. For example, Bodenhausen, Sheppard, and Kramer (1994) found that sadness (an emotion low in arousal) and anger (an emotion high in arousal) had opposite effects on cognitive processing, with angry individuals relying more on stereotypes and heuristic cues. In a related study, Bodenhausen, Kramer, and Süsser (1994) found that happy individuals made more stereotypic judgments than individuals in a neutral condition, indicating similar effects of anger and happiness. Different effects of anger and sadness, and similar effects of anger and happiness, suggest that arousal may be more important than assumed by advocates of the valence-based approach.

Based on the above findings, we hypothesise that:

H1: Arousal, rather than valence, will influence cognitive processing in the subsequent decision-making task.

2.1.2. Arousal and Cognitive Processing

In contrast to valence, which has consistently been defined as a subjective experience along the pleasure-displeasure dimension, arousal has been defined in a variety of ways, varying in the extent to which it is defined in a narrow or broad sense (Russell, 2003). In a broad sense, arousal reflects feelings of activation or alertness (Thayer, 1967, 1978). In a more narrow sense, arousal has been likened with any single indication of peripheral autonomic activity, such as blood pressure, pupil dilation, heart rate, or electrodermal response (Russell, 2003). Thus, definitions vary in the extent to which they include subjective and/or physiological aspects of arousal (Schachter & Singer, 1962). We define arousal in line with Russell's (2003) definition, viewing it as a state of readiness for action or energy expenditure at one extreme versus need for sleep and rest at the other. Moreover, we view arousal as a state of the central nervous system, reflected in both physiological responses and subjective experiences. As such, we want to explore arousal in a broader sense, valuing both its subjective and physiological aspects.

Few studies have investigated the effects of *incidental* arousal (i.e., whether and how arousal carries over from one situation to the next and affects JDM outcomes). The majority of research has focused on the effects of arousal in relation to *integral* emotions, including studies investigating the somatic marker hypothesis (Damasio, Everitt, & Bishop, 1996). These studies suggest that integral arousal may be beneficial for normatively correct decision-making by acting as valuable information (Blanchette & Richards, 2010). Effects of incidental arousal are much less clear, but it is likely that incidental arousal, as incidental emotion in general, has mostly biasing effects on JDM outcomes (Lerner, et al., 2015). Cognitive processing is an interesting case in this respect, since both analytic and intuitive processing can be related to normatively correct decision-making, depending on situational context and task requirements (M. Sinclair & Ashkanasy, 2005).

Classical contributions to the understanding of arousal effects include the Yerkes-Dodson law and Easterbrook's hypothesis, both concentrating on arousal in relation to attention and cognitive performance (Kahneman, 1973). Easterbrook's hypothesis (1959) suggests that arousal reduces attention and cue utilisation, thus hindering performance on tasks requiring attention to a lot of information at the same time, leading to reduced capacity for simultaneous information processing. Moreover, subjects are able to remember only restricted amounts of information when exposed to high arousal (Hanoch & Vitouch, 2004). Consequently, increases in arousal reduce individuals' capacity to pay attention to details and identity relevant connections, which are important aspects of analytic processing (Bakken, et al., 2016). Therefore, we can assume that increased levels of arousal, through its influence on information processing capacity, will be related to increased intuitive processing and decreased analytic processing.

A related argument can be found within literature on arousal and memory. Corson and Verrier (2007) found that false memories were significantly more frequent under conditions of high arousal, than in conditions of low arousal. This activation process of false memories seems to depend on arousal, rather than valence, as "certain mood-congruence effects observed for positive moods appear only in high arousal conditions or disappear when a relaxation session diminishes the level of arousal" (Corson & Verrier, 2007). Furthermore, individuals in conditions of high arousal have been found to ignore the presence of misinformation and report fewer central details (Porter, Spencer, & Birt, 2003). These findings may be explained by a decrease in analytic processing, manifested in decreased attention to relevant information and central details, and an increase in intuitive processing, manifested in increased reliance on false memories.

Support for the relationship between arousal and cognitive processing can also be drawn from literature on stress. Although not synonymous, arousal and stress are closely related. Stress can be defined as “a state of high general arousal and negatively tuned but unspecific emotion, which appears as a consequence of stressors (i.e., stress-inducing stimuli or situations) acting upon individuals” (Boucsein, 2012, p. 381). It follows from this definition that arousal is an essential part of stress. Although most studies have investigated stress in negative contexts (i.e., distress), stress can also be experienced in positive contexts (i.e., eustress). Both are associated with increased activation of the autonomic nervous system or increased physiological arousal (Boucsein, 2012).

Acute and severe stress has shown to impair cognitive functions of the prefrontal cortex (PFC), and switch control of behaviour and emotion to more primitive brain circuits, including the amygdala (Arnsten, 2009). Under conditions of stress, the amygdala activates stress pathways, evoking high levels of dopamine and noradrenaline. In these situations, human attention “switches from thoughtful ‘top-down’ control by the PFC that is based on what is most relevant to the task at hand, to ‘bottom-up’ control by the sensory cortices” (Arnsten, 2009, p. 4). As the brain’s responses switch from slow and thoughtful regulation by the PFC to more rapid and reflexive responses by the amygdala, individuals’ working memory and reasoning abilities are impaired (Pham, 2007). According to Lieberman (2007), these changes in the brain’s responses can also be seen as a shift from the C-system (i.e., the reflective system) to the X-system (i.e., the reflexive system). The X-system and the C-system correspond roughly to intuitive and analytic processing modes, respectively (Lieberman, 2007).

Based on findings above, we can assume that incidental arousal will be negatively related to analytic processing and positively related to intuitive processing. We are aware that arousal might influence cognitive performance in a curvilinear manner, as depicted by the Yerkes-Dodson law from 1908 (i.e., performance first improves before it declines). However, we are not likely to capture any “sleepy” arousal levels, as subjects are awake and asked to pay attention during the experiment. Therefore, we expect to find a linear relationship between arousal and cognitive processing.

H2a: Arousal will be negatively related to analytic processing in the subsequent decision-making task.
H2b: Arousal will be positively related to intuitive processing in the subsequent decision-making task.

2.2. Physiological and Subjective Aspects of Emotion

Ever since William James (1884) argued that emotions are secondary to physiological phenomena, emotion theorists have been concerned with the question of what constitutes emotional experience (Dalgleish, 2004). A key distinction is drawn between physiological reactions to stimuli and subjective experiences of these (Schachter & Singer, 1962). Contemporary theories on emotion vary in the extent to which they emphasise the one or the other (Russell, 2003), but most theories include both physiological and subjective aspects in their definition of emotion (Power & Dalgleish, 2007).

The advancement of techniques to measure physiological reactions gave rise to psychophysiology, a field concerned with “the scientific study of social, psychological, and behavioural phenomena as related to and revealed through physiological principles and events in functional organisms” (Cacioppo, Tassinary, & Berntson, 2007, p. 4). Despite the central role of physiological aspects in emotion, measures from psychophysiology are rarely included in studies investigating the effects of emotions on JDM outcomes (Blanchette & Richards, 2010). The present study includes a measure of electrodermal activity (EDA) as an indication of subjects’ physiological arousal. EDA, a phenomenon discovered in the late 1800’s, refers to “the variation of electrical properties of the skin in response to sweat secretion” (Benedek & Kaernbach, 2010, p. 80), and is related to changing activity in the eccrine sweat glands (Boucsein, 2012). Thermoregulation is the primary function of most eccrine sweat glands, but those located on the palms and underneath hands (i.e., the palmar and plantar surfaces) are found to be more responsive to psychologically significant stimuli and sympathetic activity in the autonomic nervous system (M. E. Dawson, Schell, &

Filion, 2007). Thus, EDA may give a good indication of people's physiological arousal.

As noted above, arousal may be defined in both narrow and broad terms. Physiological arousal, measured by EDA, represents a narrow definition, in contrast to Russell's (2003) definition of arousal that also includes the subjective feeling of being aroused. Interestingly, self-reported arousal (i.e., subjective feeling of arousal) is not necessarily highly correlated with measures of physiological arousal (e.g., Mandler, Mandler, Kremen, & Sholiton, 1961; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Stemmler, 1992; Sze, Gyurak, Yuan, & Levenson, 2010; Weinstein, Averill, Opton Jr, & Lazarus, 1968), indicating only modest support for the premise of response coherence in emotion advocated by prominent emotion theorists (e.g., Ekman, 1992; Lazarus, 1991). This may reflect a tendency for individuals to respond very differently following the same emotional stimulus, in terms of both physiological reactions and subjective experience. Thus, we believe that the inclusion of EDA is valuable. However, people's arousal experience and its effects cannot be reduced to physiological arousal alone; measures of different aspects of arousal (i.e., subjective and physiological) may have similar, but independent effects on cognitive processing.

H3a: Both physiological and subjective arousal will be negatively related to analytic processing in the subsequent decision-making task.
H3b: Both physiological and subjective arousal will be positively related to intuitive processing in the subsequent decision-making task.

2.3. Cognitive Appraisals

In an attempt to expand the understanding of incidental emotions and their effects, Lerner and Keltner (2000, 2001) point to the importance of examining cognitive appraisals underlying emotions. *The appraisal-tendency framework* postulates that incidental emotions predispose individuals to appraise future situations in certain ways, with consequences for JDM outcomes. Angie, Connelly, Waples, and Kligyte (2011) found support for this argument in their meta-analysis. Overall, emotions were found to have moderate to large effects on JDM outcomes in ways that could be explained by predictions derived from the appraisal-tendency framework. The framework is often presented as an independent perspective on incidental emotions, aimed mainly at producing findings contradicting the valence-based approach. Unlike its most eager advocates, we choose to see the appraisal-tendency framework as a supplementary perspective, rather than a competing one, and aim at investigating whether its insights add to our understanding of the influence of incidental emotions on cognitive processing. Specifically, we see cognitive appraisals as important aspects of the subjective experience of emotion alongside and across perceived valence and perceived arousal.

The appraisal-tendency framework specifies six cognitive appraisal dimensions, based on work by Smith and Ellsworth (1985): Pleasantness, anticipated effort, certainty, attentional activity, self-other responsibility/control, and situational control. Smith and Ellsworth (1985) found that "emotions varied systematically along each of these dimensions, indicating a strong relation between the appraisal of one's circumstances and one's emotional state" (p. 813). The importance of cognitive appraisals in emotional experience is a common argument among contemporary emotion theorists (Power & Dalgleish, 2007). What makes appraisal-*tendencies* novel is the argument that cognitive appraisals are not only relevant for classifying emotional experience, but also for making predictions about how incidental emotions influence JDM outcomes. Lerner and Keltner (2000) argue that each emotion can potentially influence individuals to perceive new situations in ways that are similar to the cognitive appraisals that triggered the emotion:

> Drawing on evidence that each specific emotion (a) is defined by a set of central dimensions and (b) directs cognition to address specific problems or opportunities, we hypothesise that each emotion activates a cognitive predisposition to appraise future events in line with the central-appraisal dimensions that triggered the emotion – what we call an appraisal tendency. In short, appraisal tendencies are goal-directed processes through which emotions exert effects on judgement and choice until the emotion-eliciting problem is resolved. (Lerner & Keltner, 2000, p. 477)

In short, the carry-over process of incidental emotions works by colouring the perception and interpretation of new stimuli through a sequence of appraisal→emotion→appraisal-tendency.

2.3.1. Cognitive Appraisals and Cognitive Processing

The relevance of looking beyond core affect, and to cognitive appraisals, is supported by findings from studies investigating the effects of discrete emotions. As noted, several studies have found emotions of the same valence to produce different effects on cognitive processing, and emotions of different valence to produce similar effects (e.g., Bodenhausen, Kramer, et al., 1994; Bodenhausen, Sheppard, et al., 1994; Lerner & Tiedens, 2006; Tiedens & Linton, 2001). Interestingly, some studies have found that similar differences persist even when arousal is taken into account. Anger and fear are similar in both valence and arousal, but have been found to produce opposite effects on risk perception and behaviour (Habib, Cassotti, Moutier, Houdé, & Borst, 2015; Kugler, Connolly, & Ordóñez, 2012; Lerner, Gonzalez, Small, & Fischhoff, 2003; Lerner & Keltner, 2001). For example, in a study by Lerner and Keltner (2001), angry individuals made optimistic judgments of future events, and fearful individuals made pessimistic judgments.

Tiedens and Linton (2001) argue that cognitive components of emotion are particularly important when investigating its cognitive consequences. The appraisal-tendency framework offers opportunities to make specific predictions of how incidental emotions influence cognitive processing, by analysing appraisal tendencies relevant for this outcome. According to Tiedens and Linton (2001), *certainty appraisals* are especially relevant for cognitive processing. Certainty can be defined as “the degree to which future events seem predictable and comprehensible (high) vs. unpredictable and incomprehensible (low)” (Lerner & Keltner, 2000, p. 479). Tiedens and Linton (2001) found that emotions characterised by certainty appraisals promoted higher levels of intuitive processing in subsequent situations, compared to emotions associated with uncertainty appraisals. Bagneux, Font, and Bollon (2013) found similar results: Individuals induced with uncertainty emotions engaged more in analytic processing, compared to individuals induced with certainty emotions, who engaged more in intuitive information processing. Based on these findings, we can expect individuals who perceive low certainty to engage in higher levels of analytic processing in order to increase the predictability and comprehensibility of the situation, whereas individuals who perceive high certainty do not feel the need to analyse the situation and will be more intuitive in their processing.

H4a: Certainty appraisals will be negatively related to analytic processing in the subsequent decision-making task.
H4b: Certainty appraisals will be positively related to intuitive processing in the subsequent decision-making task.

Based on studies linking motivation and information processing (e.g., Humphreys & Revelle, 1984; Kahneman, 1973), we regard *anticipated effort appraisals* as a relevant dimension in addition to certainty. Anticipated effort concerns "the degree to which physical or mental exertion seems to be needed (high) vs. not needed (low)" (Lerner & Keltner, 2000, p. 479). As previously noted, analytic processing demands mental effort and cognitive resources from individuals. Thus, we expect individuals who anticipate low effort to be more intuitive as the situation signals that high mental effort is not needed. In contrast, we expect individuals who anticipate high effort to engage more in analytic processing to match their perceptions of situational demands.

H5a: Anticipated effort appraisals will be positively related to analytic processing in the subsequent decision-making task.
H5b: Anticipated effort appraisals will be negatively related to intuitive processing in the subsequent decision-making task.

2.3.2. Does Physiological Arousal Increase or Decrease the Salience of Cognitive Appraisals?

An interesting question that has received little attention in research on incidental emotions is whether physiological and subjective aspects of emotion interact to produce complex effects on JDM outcomes. Schachter and Singer (1962) famously argued that physiological arousal and cognition interact to produce specific emotional states. Cognition determines how the individual interprets and labels a certain state of physiological arousal, meaning that the same physiological arousal level can be interpreted as any emotional state based on the cognitive aspects of the situation (Schachter & Singer, 1962). This perspective defines physiological arousal as "a peripheral physiological component providing an emotion's intensity" (Russell, 2003, p. 153). Based on this definition, we argue that besides having direct effects on cognitive processing, physiological arousal may also influence cognitive processing by making other aspects of emotion, such as cognitive appraisals, more or less salient. On the one hand, physiological arousal may function as a facilitator for the transfer of cognitive appraisals from one situation to the next, increasing people's tendencies to perceive new situations in line with existing cognitive appraisals. On the other hand, physiological arousal may override all other aspects of emotion and trigger a more stress-related autonomic response (Arnsten, 2009), inhibiting the manifestation of these tendencies. Both mechanisms seem feasible, making it difficult to determine the nature of the moderation effect. Given the novelty of this line of reasoning, we take a more explorative view in this part of the study, hypothesising:

H6: Physiological arousal will moderate the influence of certainty appraisals and anticipated effort appraisals on cognitive processing in the subsequent decision-making task.
H6a: As the level of physiological arousal increases, the relationship increases.
H6b: As the level of physiological arousal increases, the relationship decreases.

3. Methodology

3.1. Sample

In total, 131 subjects (90 female) participated in the experiment in exchange for a personalised feedback report and a chance to win 200 NOK gift cards. The majority of subjects were students at large academic institutions in Norway (108 students, mean age 25 years). Seven subjects had missing values on central variables, and four subjects were excluded due to abnormal ratings of the emotional stimulus[1]. This resulted in a final sample of 120 subjects distributed across four experiment conditions. Prior to data collection, the study was notified to the Norwegian Centre for Research Data (NSD).

[1] Subjects with abnormal ratings were defined as those deviating from expected ratings on valence in each experiment condition. Deviant ratings were identified using the STATA-command *extremes* developed by Cox (2004). We used the following criterion for exclusion: Those subjects who rated the positive pictures as clearly negative (3 or below) and the negative pictures as clearly positive (6 or above) were seen as deviant and excluded from further analysis.

3.2. Data Collection

3.2.1. Experimental Design and Equipment

The overall aim of this study was to investigate the effect of subjective and physiological aspects of incidental emotions on subjects' cognitive processing in a subsequent decision-making context. We randomly assigned subjects to four different experiment conditions, differing only in the target emotion induced in the experiment. The target emotions were selected based on the core affect construct (Russell, 2003), covering the four main combinations of valence and arousal: (1) positive valence, high arousal; (2) positive valence, low arousal; (3) negative valence, high arousal; and (4) negative valence, low arousal. The target emotions were induced using pictures with different emotional content from the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 2008). These pictures are validated in terms of valence and arousal, and we chose pictures expected to induce the target emotions above. Various methods for emotion induction exist. Although other methods (e.g., film clips, scenarios) can induce stronger emotion in subjects, pictures with emotional content provide a simple and fast way of inducing emotion in laboratory settings. See section 3.4. for manipulation checks.

As decision-making context, we used the gain frame version of the Asian disease problem (Tversky & Kahneman, 1981). This scenario is widely used within the JDM field, allowing for comparison of findings across studies. Furthermore, unlike other decision-making tasks, the Asian disease problem has no right or wrong answer (unlike for example the Iowa gambling task (Bechara, Damasio, Tranel, & Damasio, 1997) and does not itself put strong constraints on subjects' cognitive processing (unlike for example the "Cognitive Reflection Test" (Frederick, 2005)). Based on the requirements of the Asian disease problem alone, subjects are equally likely to adopt intuitive and analytical processing modes, which makes this task suitable for studying the effects of incidental emotions on cognitive processing.

Upon arrival and after having signed a consent form for participation, subjects were connected to the Biogauge Sudologger (Tronstad et al., 2008), which measures EDA by applying a very small electric current (30 mV) to the skin beneath three measuring electrodes connected to palm and forearm of subjects' non-dominant hand. The Biogauge Sudologger recorded subjects' electrodermal responses (EDRs) at a sampling frequency of 1.1111 Hz (i.e., every 0.9 second). The data were extracted and analysed in the software Ledalab 3.4.8 written in MATLAB. The software is available online free of charge (www.ledalab.de). See measures section for an extended description of analytic procedures.

The experiment was presented electronically using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA), enabling us to integrate timings of emotional stimuli and subjects' EDRs following these stimuli with reasonable accuracy (see measures section).

3.2.2. Experimental Procedure

Subjects were shown a black screen and told to relax for 60 seconds at the start of the experiment, before a picture with emotional content were shown on the screen for three seconds, immediately followed by the short decision-making task with the same picture still in the background. After the task, subjects answered several questions regarding their subjective emotional experience of the picture, including the self-assessment manikin (SAM) of valence and arousal (Bradley & Lang, 1994) and questions related to cognitive appraisals in emotions (Smith & Ellsworth, 1995) (see measures section). After the experiment, subjects answered a survey administered using Qualtrics (Qualtrics, Provo, UT), assessing their cognitive processing during the decision-making task (see measures section below).

3.3. Measures

3.3.1. Dependent Variables

Cognitive processing during the decision-making task was measured by the 22-item version of the Cognitive Processing Inventory (CPI) developed by Bakken, et al. (2016). The CPI represents cognitive processing as a five-dimensional construct consisting of the dimensions rational (5 items), control (6 items), urgency (4 items), affective (3 items), and knowing (4 items). The questionnaire contains items such as "I evaluated systematically all key uncertainties" and "I made the decision because it felt right to me". All items were rated on a scale from 1 (strongly disagree) to 5 (strongly agree). For our final analyses, we used the two higher-order dimensions analytic processing (consisting of rational and control) and intuitive processing (consisting of urgency and affective). See below for a discussion on the dimension knowing.

Descriptive statistics for the cognitive processing construct are presented in table 4.1. All scales had (close to) acceptable reliabilities of .70. A confirmatory factor analysis indicated that the model proposed by (Bakken, et al., 2016) provided close to good fit ($X^2(199)=283.72$, RMSEA=0.06, CFI=0.89).

Table 4.1: *Descriptive statistics for CPI (means, standard deviations, intercorrelations, scale reliabilities (in bold)).*

	Mean	SD	1	2	3	4	5
1. Rational	3.80	0.77	**.82**				
2. Control	3.50	0.60	.50***	**.61**			
3. Urgency	2.54	0.93	-.35***	-.24**	**.83**		
4. Affective	3.41	0.96	-.12	-.15	.22*	**.78**	
5. Knowing	2.67	0.82	.26**	.14	.07	.05	**.64**

Note. † p < 0.10. * p < 0.05. ** p < 0.01. *** p < 0.001.

Most correlations in table 4.1 are in expected directions, except for the significant positive correlation between rational and knowing. Theoretically, knowing is assumed to contribute to intuitive processing together with affective and urgency. However, we found that knowing did not significantly correlate with these two. Bakken, et al. (2016) pointed to a similar ambiguity, and encouraged further investigation into how this dimension relates to the other four. Due to this ambiguity, we chose to exclude this dimension from further analysis. As noted above, we combined rational and control into an analytic processing scale and affective and urgency into an intuitive processing scale, to ease subsequent analyses.

3.3.2. Independent Variables

Perceived valence and arousal. Perceived valence and arousal were measured using SAM, a non-verbal self-assessment technique commonly used to assess subjects' emotional reactions to various stimuli, including pictures (Bradley & Lang, 1994). Subjects rated how they felt when looking at the picture on the screen on a scale from 1 (unhappy) to 9 (happy) for valence, and on a scale from 1 (calm) to 9 (excited) for arousal.

Cognitive appraisals. Cognitive appraisals were measured by questions developed by Smith & Ellsworth (1995), with three items measuring certainty

(α=.70) (e.g., “How uncertain are you about what is happening in this situation?”), and two items measuring anticipated effort (α=.72) (e.g., “how much effort (mental or physical) do you feel this situation require you to expend?”). All items were rated on a scale from 1 (not at all) to 11 (extremely).

Physiological arousal. EDA is divided into tonic (i.e., EDL = electrodermal level) and phasic (i.e., EDR = electrodermal response or reaction) components (Boucsein, 2012). To obtain a measure of subjects’ physiological reactions to the emotional stimuli, we decomposed the electrodermal recordings into continuous signals of tonic and phasic activity using Continuous Decomposition Analysis (CDA), proposed by Benedek and Kaernbach (2010). The resulting phasic driver has “a virtual zero baseline and distinct phasic responses” (Benedek & Kaernbach, 2010, p. 82). A key advantage of this method (as opposed to the classic Trough-to-peak method) is a reduced risk of underestimating EDR amplitudes due to superimposed EDRs (Benedek & Kaernbach, 2010).

After decomposition, we extracted several phasic parameters using an amplitude criterion (i.e., threshold for a EDR to be registered) of 0.05 muS and a response window of 0.9 to 4.5 seconds following the onset of the emotional stimuli. According to Boucsein (2012), EDR amplitudes are the most frequently used measures in studies investigating event-related EDA. Thus, we used the sum of EDR amplitudes of significant EDRs within the response window (EDR.AmpSum) as our primary measure of subjects’ physiological reactions[2].

Due to response latencies, we cannot observe changes in EDRs immediately following emotional stimuli (Boucsein, 2012). Observed latencies vary across studies, but latencies exceeding 4 seconds are rare (Venables & Christie, 1980). Levinson and Edelberg (1985) found that response windows of 1 to 4 seconds and 1 to 5 seconds were the most frequently used in studies published in the journal *Psychophysiology*, and recommended to adjust windows based on observed latencies for each study. With a response window of 0.9 to 4.5 seconds, we observed a mean latency of 1.74 seconds, close to the characteristic value in comfortable room temperature of 1.8 seconds (Edelberg, referenced in

[2] Other parameters were also extracted, such as number of significant EDRs within response window, average phasic driver within response window, and maximum phasic driver within response window.

Boucsein, 2012). This window captured significant EDRs from 77 % of subjects. A longer window would have captured EDRs from more subjects, but interpreting these responses as stimulus-specific is problematic. First, a longer window would have increased the likelihood of counting nonspecific EDRs as stimulus-related EDRs considerably. M. E. Dawson, et al. (2007) recommend shorter rather than longer windows to reduce the risk of interferences from nonspecific EDRs as much as possible. Second, a short window makes us confident that we are actually studying the effects of incidental emotions, as a longer window (e.g., 10 seconds) is likely to capture EDRs related to the task as well. Thus, a response window of 0.9 to 4.5 seconds is justifiable on both theoretical and methodological grounds.

Control variables. Numerous studies have found that men and women respond differently to the same emotional stimulus (e.g., Brody, Lovas, & Hay, 1995; Fessler, Pillsworth, & Flamson, 2004; Hofer et al., 2006; Wrase et al., 2003). Women tend to respond more negatively to negative stimuli, and men tend to respond more positively to positive stimuli (Stevens & Hamann, 2012). There is also a tendency for women to rate negative stimuli as more arousing, in contrast to men, who tend to rate positive stimuli as more arousing ((Bradley, Codispoti, Sabatinelli, & Lang, 2001). The four experiment conditions had approximately the same ratio between men and women (1:2). To further limit the confounding effects gender differences represent, we controlled for gender (female=0) in all regression models.

3.4. Manipulation Checks

To investigate the effectiveness of our emotion induction, we carried out a series of between-subjects t-tests (see table 3.1 for an overview of experiment conditions and observed means). Manipulation checks showed that subjects in the two positive conditions (M = 6.40, SD = 1.44) reported significantly higher valence than subjects in the two negative conditions (M = 2.75, SD = 1.22), $t(118)$ = 15.08, $p < .001$. Furthermore, subjects in the positive high arousal condition (M = 5.00, SD = 1.96) reported significantly higher arousal than subjects in the positive low arousal condition (M = 3.68, SD = 1.49), $t(55)$ = 32.85, $p < .01$. However, subjects in the two negative conditions did not significantly differ in perceived arousal levels, $t(61)$ = 0.29, $p > .05$, but observed means in table 3.1 are in expected directions.

In terms of EDR, subjects in the two positive conditions did not significantly differ, $t(55) = -1.40$, $p > .05$, nor did subjects in the two negative conditions, $t(61) = 1.46$, $p > .05$. Contrary to expectations, mean physiological arousal was higher for subjects in the positive low arousal condition than for subjects in the positive high arousal condition. Means for the two negative conditions were in expected directions. Both differences were close to significant ($p < .10$).

Table 3.1: Experiment conditions and observed means (and standard deviations) of perceived valence, perceived arousal, and physiological arousal

Condition	Perceived valence	Perceived arousal	Physiological arousal	Picture description
1: Positive valence, high arousal	6.00 (1.36)	5.00 (1.96)	0.17 (0.19)	Person surfing in the air
2: Positive valence, high arousal	6.82 (1.41)	3.68 (1.49	0.41 (0.92)	Baby smiling to the camera
3: Negative valence, high arousal	2.75 (1.24)	4.03 (1.86)	0.31 (0.43)	Man carrying a child's body covered in blood
4: Negative valence, low arousal	2.74 (1.21)	3.90 (1.70)	0.19 (0.22)	Child starving in the desert

In sum, our emotion induction was effective in producing expected differences in valence between conditions. However, it largely failed to produce expected differences in both arousal measures. Thus, results should be interpreted with caution. See a further discussion of this and other issues related to emotion induction with pictures in the discussion.

4. Results

4.1. Descriptive Statistics

Table 4.1 shows correlations between all dependent and independent variables in the study. In addition, we included task response time (in seconds) in order to validate the two cognitive processing dimensions. Based on common definitions of intuitive processing as fast, and analytic processing as slow, we expected intuitive processing to be negatively related to response time and analytic processing to be positively related. As expected, we observed a significant positive correlation for intuitive processing, indicating that subjects who reported high levels of intuitive processing used less time answering the task than those who reported lower levels. We also observed a weak, and insignificant, positive correlation between analytic processing and response time. Furthermore, there was a significant negative correlation between the two processing modes. However, the correlation was only moderate, supporting the notion of two interdependent systems that operate side-by-side (Bakken, et al., 2016).

Interestingly, we observed significant correlations between perceived valence and cognitive appraisals. Valence was positively related to certainty appraisals and negatively related to anticipated effort appraisals, indicating that people exposed to positively valenced stimuli evaluated the situation as significantly more certain and significantly less demanding than those exposed to negatively valenced stimuli. These correlations are expected, and may be taken as an informal validation of the two cognitive appraisal dimensions. Other correlations worthy of attention were (nearly) significant correlations between intuitive processing and valence and arousal measures in expected directions, and a significant negative correlation between physiological arousal and analytic processing. Furthermore, we observed no significant correlation between physiological and perceived arousal, strengthening our argument that these can be seen as two separate dimensions in a broad definition of arousal.

Table 4.1: Correlation matrix

	1	2	3	4	5	6	7	8
1. Intuitive processing	-							
2. Analytic processing	-.32***	-						
3. Perceived valence	.17†	-.10	-					
4. Perceived arousal	.18*	-.11	-.01	-				
5. Physiological arousal	.16†	-.21*	.13	-.09	-			
6. Certainty appraisals	.07	.14	.22*	.10	-.06	-		
7. Anticipated effort appraisals	-.15	.08	-.48***	.16†	-.05	-.03	-	
8. Task response time	-.25**	.10	.08	-.04	.11	-.02	.04	-

Note. † $p < 0.10$ * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

4.2. Incidental Emotions and Cognitive Processing

In order to evaluate the main effect of experiment condition on the dependent variables, we performed ANOVA tests of group means. We found no significant main effect of experiment condition on analytic processing ($F(3, 116) = 0.22$, $p > .05$) or intuitive processing ($F(3, 116) = 0.95$, $p > .05$). This comes as no surprise, since our emotion induction did not produce expected differences between conditions. This is in line with our expectation that people can experience the same emotional stimulus very differently, strengthening our arguments for regression analyses based on subjects' individual responses. A key assumption in the dominant perspective on emotions (i.e., the circumplex model or core affect) is that valence and arousal account for most of the variation between emotional states. In analyses below, we took this assumption as our starting point. For an investigation of the appropriateness of this assumption, see the post-hoc analysis.

In order to test our hypotheses, we performed multiple linear regressions with intuitive and analytic processing as dependent variables. We performed the same hierarchical regressions for the two dependent variables separately (see table 4.2). The results largely support hypothesis 1 concerning the primacy of arousal over valence. Notwithstanding the nearly significant ($p = .09$) positive effect of valence on intuitive processing in model 1, incidental arousal, rather than incidental valence, seems to be important for cognitive processing. Furthermore, the results support our general hypotheses regarding effects of arousal (H2a and H2b); arousal measures were negatively related to analytic processing and positively related to intuitive processing.

The results also support hypotheses specifying the effects of physiological and perceived arousal. First, physiological arousal was significantly related to cognitive processing in predicted directions, exhibiting a significant positive relationship with intuitive processing and a significant negative relationship with analytic processing. For perceived arousal, the same significant positive relationship was found with intuitive processing, and we also observed a tendency in the data ($p = .08$) for a negative relationship with analytic processing. These findings provide full support for hypothesis 3a, and partial support for hypothesis 3b. In sum, both physiological and perceived arousal contribute to the effects of incidental emotions on cognitive processing.

We did not observe significant direct effects of certainty appraisals or anticipated effort appraisals in predicted directions, rejecting hypotheses 4 and 5. Interestingly, we did observe a significant effect of certainty appraisals on analytic processing, but in opposite direction of what was hypothesised in H4a. Although hypotheses are rejected, this significant positive relationship may be interpreted as partial support for the appraisal-tendency framework in general, which argues that cognitive appraisals are important aspects when studying the effects of incidental emotions on cognitive phenomena (Tiedens & Linton, 2001).

Table 4.2: *Multiple linear regression analyses. N=120.*

	Dependent variable: Intuitive processing					
	Model 1		Model 2		Model 3	
	B	*SE(B)*	*B*	*SE(B)*	*B*	*SE(B)*
Physiological arousal	0.220*	0.09	0.228*	0.09	0.175	0.25
Perceived arousal	0.081*	0.04	0.088*	0.04	0.081*	0.04
Perceived valence	0.050†	0.03	0.026	0.03	0.027	0.03
Certainty appraisals			0.013	0.04	0.010	0.04
Anticipated effort appraisals			-0.040	0.03	-0.038	0.03
Certainty appraisals x physiological arousal					-0.075	0.12
Anticipated effort appraisals x physiological arousal					-0.022	0.06
Gender	0.005	0.15	0.008	0.15	'0.019	0.15
Constant	2.978***	0.07	2.977***	0.07	2.967***	0.07
R^2	0.09		0.10		0.11	
Adj. R^2	0.06		0.05		0.04	
F for change in R^2	4.35**		0.88		0.19	

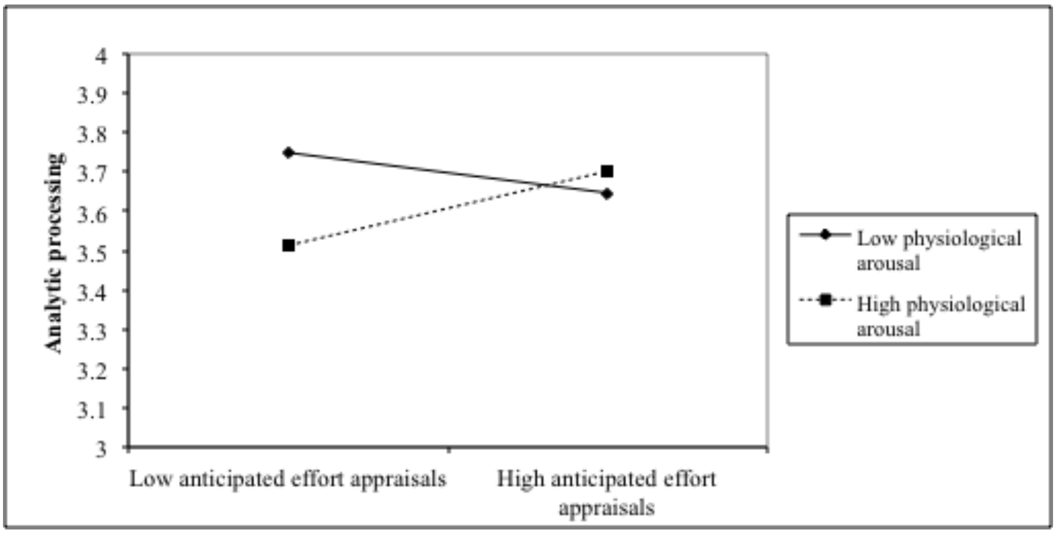
	Dependent variable: Analytic processing					
	Model 1		Model 2		Model 3	
	B	*SE(B)*	*B*	*SE(B)*	*B*	*SE(B)*
Physiological arousal	-0.245***	0.07	-0.231***	0.07	-0.084	0.11
Perceived arousal	-0.042	0.03	-0.051†	0.03	-0.043	0.03
Perceived valence	-0.019	0.02	-0.022	0.03	-0.028	0.03
Certainty appraisals			0.050*	0.02	0.053*	0.02
Anticipated effort appraisals			0.015	0.03	0.009	0.03
Certainty appraisals x physiological arousal					-0.005	0.08
Anticipated effort appraisals x physiological arousal					0.056†	0.03
Gender	0.000	0.12	0.006	0.11	0.001	0.12
Constant	3.649***	0.07	3.648***	0.07	3.653***	0.07
R^2	0.07		0.10		0.12	
Adj. R^2	0.03		0.05		0.05	
F for change in R^2	6.04***		2.52†		2.03	

Note. Predictors centered at their means. Robust standard errors due to heteroscedasticity.
† $p < 0.10$. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

The results did not show significant moderation effects of physiological arousal on the relationship between cognitive appraisals and cognitive processing. Thus, hypothesis 6 is rejected. However, the interaction term between anticipated effort appraisals and physiological arousal was close to significant (p = .06) in the model for analytical processing, indicating a tendency for the relationship between anticipated effort appraisals and analytical processing to *differ* depending on level of physiological arousal. Interestingly, the interaction plot in figure 4.1 shows that physiological arousal moderated the *direction* of the relationship between anticipated effort appraisals and analytic processing; the effect of anticipated effort appraisals was negative for those with low physiological arousal and positive for those with high physiological arousal. In other words, we observed a positive relationship between anticipated effort appraisals and analytic processing (as hypothesised in H5) in cases of high physiological arousal, whereas the relationship was *opposite* in cases of low physiological arousal. We only hypothesised that physiological arousal would moderate the *strength* of the relationship, which makes this finding both interesting and surprising.

A simple slope test (J. F. Dawson, 2014) showed that the slopes plotted below failed to reach a significance level of .05 (p = .157 for high physiological arousal; p = .548 for low physiological arousal). An investigation of regions of significance (Aiken, West, & Reno, 1991) indicated that the relationship would be significant in cases of physiological arousal levels from two standard deviations above the mean. Thus, for these subjects we indeed observed a significant positive relationship between anticipated effort appraisals and analytic processing.

Figure 4.1: *Interaction plot: Physiological arousal and anticipated effort appraisals on analytic processing (low=1 SD below the mean; high=1 SD above the mean).*



In sum, our findings largely support hypotheses concerning the importance of both perceived and physiological arousal (rather than perceived valence), with strongest support for physiological arousal. Our findings provide limited support for hypotheses derived from the appraisal-tendency framework. Neither certainty appraisals nor anticipated effort appraisals were significantly related to cognitive processing in expected directions, but the former were significantly related to analytic processing in the opposite direction. Finally, even though hypothesised relationships were not supported, our investigation of interaction effects generated some interesting findings indicating a near significant interaction between anticipated effort appraisals and physiological arousal.

4.3. Post-hoc analysis

A post-hoc analysis was conducted to investigate whether the independent variables collectively could account for differences between experiment conditions, motivated by the assumption that valence and arousal account for most of the variation between emotional states. By doing so, we were also able to evaluate to which extent it was appropriate to proceed with regression analyses based on this assumption. We performed multinomial logistic regressions treating experiment conditions as dependent variable. In model 1 we included perceived arousal, perceived valence, and physiological arousal as independent variables to test the underlying assumption of the core affect perspective, and added certainty appraisals and anticipated effort appraisals in model 2 based on arguments made by the appraisal-tendency framework. These analyses generated interesting results worth commenting on. Although model 1 provided good overall fit compared to an intercept-only model (X^2 (9, N = 120) = 147.06, $p < .001$, Nagelkerke $R^2 = .75$), model fit significantly increased in model 2 (X^2 (15, N = 120) = 163.10, $p < .001$, Nagelkerke $R^2 = .79$), compared to model 1 (X^2 (6, N = 120) = 12.87, $p < .05$). This was accompanied by an increase in the model's overall predictive quality; 57.5 % was classified correctly in model 1 compared to 63.3 % in model 2. This improvement was due to an increase in predictive quality for negative conditions, indicating that cognitive appraisals were important for distinguishing between subjects in these two conditions.

Closer inspection revealed condition-specific differences. Certainty appraisals were the only variable significant in distinguishing between the two negative conditions; subjects perceived condition 3 as significantly less certain than condition 4 ($OR_{\text{condition 3/4}} = 0.75$, $p < .05$). Anticipated effort appraisals significantly distinguished the positive low arousal condition (condition 2) from the two negative conditions ($OR_{\text{condition 3/2}} = 2.03$, $p < .05$; $OR_{\text{condition 4/2}} = 1.94$, $p <$

.05). Thus, we found that cognitive appraisals differed between same-valence conditions, as well as between conditions differing in valence.

In sum, this analysis supports the assumption that valence and arousal account for most of the variation between emotional states. However, the analysis also indicates that cognitive appraisals are important for explaining responses in some conditions, and thus may add explanatory value beyond valence and arousal. For a discussion of methodological implications of these findings, see the discussion section.

5. Discussion

The main aim of this study was to investigate the effects of different aspects of incidental emotions on individuals' cognitive processing in a subsequent decision-making context. The study made several discoveries, with interesting theoretical, methodological, and practical implications.

5.1. Theoretical and Methodological Implications

5.1.1. Implications for the study of emotion and its effects

Our findings highlight the importance of both perceived and physiological aspects of incidental arousal, rather than incidental valence. Specifically, we found that arousal was negatively related to analytic processing and positively related to intuitive processing. Previous JDM research has largely concentrated on the role of incidental valence in decision-making (Lerner, et al., 2015), whereas the study of arousal has been more widespread in research on integral emotions (Blanchette & Richards, 2010). Our findings suggest that further research into the effects of incidental arousal may be fruitful. We also recommend such studies to use psychophysiological measures, such as EDA, to capture different aspects of individuals' arousal experiences. However, the lack of convergence between perceived and physiological arousal also support a broad understanding of arousal such as that proposed by Russell (2003). When studying the effects of arousal on JDM outcomes, arousal cannot be reduced to physiological arousal alone, rather, it is important to consider both its subjective and physiological aspects.

We found limited support for the appraisal-tendency framework. Specifically, we found that only certainty appraisals had significant effects on cognitive processing, and in the opposite direction of predictions based on the appraisal-tendency framework. This finding might seem surprising considering the appealing arguments made by the framework, but there are also arguments for why certainty appraisals may be related to *increased* analytic processing. For example, dealing with environmental uncertainty may take up cognitive resources and influence working memory and attention negatively. Thus, increased certainty appraisals allow people to allocate more cognitive resources to task-specific analytic processing. This finding contradicts previous findings suggesting that certainty appraisals are related to more intuitive processing and less analytic processing (Tiedens & Linton, 2001). The appraisal-tendency framework is a relatively recent development in the field of incidental emotions, and these contradictory findings indicate a need for further theoretical refinement. Future research should explore such areas as whether effects of cognitive appraisals vary across different tasks or interact with aspects other than physiological arousal.

Concerning the interplay between physiological arousal and anticipated effort appraisals, our findings suggest that integrating different emotion perspectives can be fruitful and should be explored further. We found opposite effects of anticipated effort appraisals depending on the level of physiological arousal. Thus, different aspects of emotion may interact in unexpected ways, and we encourage future research to explore mechanisms behind this finding and similar interactions. Furthermore, this interaction effect may also be interpreted the other way around, suggesting that the effect of physiological arousal may depend on other aspects of emotion, in our case, cognitive appraisals. Specifically, our findings indicate that when individuals perceive high levels of physical or mental exertion to be needed (i.e., anticipated effort appraisals), higher levels of arousal may in fact *increase* tendencies for analytic processing. Future research should go beyond the direct effect of arousal and investigate mechanisms that moderate this effect.

5.1.2. Implications for the induction and measurement of emotion

Our findings indicate that people may experience the same emotional stimulus differently, resulting in different effects on cognitive processing between individuals exposed to the same emotional stimulus. Specifically, we did not find significant differences in cognitive processing between the different experimental groups, but further analyses based on individual measures of arousal showed significant effects in expected directions. This creates challenges for experimental research where effects are often assessed on experiment group level.

Post-hoc analyses showed that perceived valence, perceived arousal, and physiological arousal accounted for 75 % of the variance between conditions, largely supporting the assumption of the core affect perspective. However, these variables failed to distinguish between the two negative conditions. When we included cognitive appraisals, the model's ability to predict correct condition significantly increased, and certainty appraisals were significant in explaining differences between the two negative conditions. Thus, our findings indicate that the pictures we used contained content beyond valence and arousal. This has implications for the use of IAPS pictures, which are commonly assumed to manipulate only valence and arousal (Bradley & Lang, 2007). Based on this line of reasoning, experimenters cannot be confident that two pictures similar in valence and arousal trigger the same emotional state in subjects. This also makes sense on an intuitive level. Why should we expect two negative pictures with very different content to trigger the same emotional episode just because they are similar in valence and arousal? If other aspects, such as cognitive appraisals, are relevant for the outcome studied, questions arise regarding what we are actually studying the effect of. We encourage future research to engage in more detailed investigations of emotion induction with pictures.

These findings also have implications for the measurement of emotion. A key argument in favour of keeping core affect at the centre of emotion measurement, is the convincing evidence of its physiological and neural correlates (e.g., Bradley & Lang, 2007; Stevens & Hamann, 2012). In contrast, other aspects of emotion are often dismissed as products of individuals' subjective evaluations, accompanied by a reference to their lack of physiological and neural bases (Russell, 2003). Admittedly, a large part of an emotional experience is likely to be subjective, complicating the study of emotion beyond well-defined dimensions such as valence and arousal. However, these arguments do not suffice the exclusion of such aspects from emotion measurement. Whether such aspects are natural kinds or mere psychological constructions (Lindquist, Siegel, Quigley, & Barrett, 2013) matters less from this viewpoint. As long as individuals see them as real, and awaringly or unawaringly act upon them in decision-making situations, emotion research should strive to also capture these. Thus, we encourage efforts into the development of measurements that better capture the totality of emotional experience.

5.2. Practical Implications

Our findings have important implications for practice. In general, they highlight that organisations should pay more attention to workers' emotional experiences at work and outside work. We found that even small increases in arousal unrelated to the task at hand may influence how people process information and make decisions. This is a highly relevant finding, since workers are continuously exposed to arousing situations, such as strict deadlines and open-plan offices. When workers need to make decisions requiring systematic and deliberate processing of information, organisations may want to facilitate working conditions that are less arousing.

However, this relationship is not black and white. Organisations should also consider the possible interplay between physiological arousal and anticipated effort appraisals, as high physiological arousal combined with high demands may actually increase analytical processing. Differently put, workers who perceive demands as high (i.e., anticipated effort appraisals), may actually benefit from being in a state of readiness for action (i.e., physiological arousal) in tasks that require analytical thinking. Thus, moderate physiological arousal may not be such a bad thing given the right circumstances, as it can enable workers to mobilise energy to perform according to expectations. Therefore, in high-demanding work environments, managers should consider the benefits of allowing for laughter, physical activity, and other arousal-increasing activities. This is in contrast to a state of high general arousal experienced as stress, which is likely to have mostly detrimental effects on cognitive functions (Arnsten, 2009), resulting in a more intuitive processing mode (Lieberman, 2007).

Implications for practice can also be drawn from our findings regarding the direct effects of cognitive appraisals. These indicate that appraisals of a situation as certain or uncertain may carry over to an unrelated situation, and influence cognitive processing. Many workers are exposed to social and economic uncertainty in the current labour market. Thus, being in an uncertain work situation may lead workers to be less attentive when making decisions at work.

5.3. Limitations

This study has several limitations. First, our emotion induction method was only partly successful in producing the experiment conditions we aimed for, and our findings should be interpreted with this in mind. The affective pictures were chosen based on validated ratings on valence and arousal, but arousal ratings in our study deviated significantly from these. Particularly, the method failed to produce conditions that significantly differed in arousal. Furthermore, we were unable to elicit high arousal in most subjects, with the highest mean score of arousal being approximately 5 (out of 9) in the positive valence/high arousal condition. Thus, whereas pictures seem to be a good method for inducing different conditions of valence, they might not be the most appropriate method for inducing differences in arousal. Recent studies have explored the possibility of using affective film clips to induce emotions in lab settings (Schaefer, Nils, Sanchez, & Philippot, 2010). Although film clips can be more ambiguous in content, which creates problems when manipulating other aspects of emotion, they may be well suited for eliciting states of high emotional arousal.

Second, EDA was the only measure of physiological arousal included in the study. Although the inclusion of EDA represents a key advantage, we could have included other measures from psychophysiology, such as heart rate and pupil dilation. Different physiological measures of emotion do not necessarily converge (Mauss & Robinson, 2009)), and the inclusion of more than one measure could have given us a more nuanced picture of the physiological aspect of emotion. On the other hand, EDA has been found to capture small changes at lower levels of physiological arousal better than other measures (Boucsein, 2012). Thus, it is likely that we captured essential differences between individuals in our study. Nevertheless, the inclusion of other physiological measures into JDM research represents a promising alley for future research, and we hope to see further applications of these in the future.

Third, our study has limitations with regards to its generalisability and relevance for real-life settings. A laboratory setting is an artificial context for the study of human behaviour in general, and particularly emotion (Mauss & Robinson, 2009). The situation is likely to elicit specific emotions in itself and can make people more aware of their cognitive and emotional processes. Moreover, emotion variables explained only a small proportion of the variation in cognitive processing, suggesting that factors other than those included in our study, are more important for cognitive processing. Furthermore, unlike experimental studies in general, we are not able to draw any causal conclusions due to the use of regression analysis. However, we were able to capture interesting findings concerning the relationship between different aspects of emotion and cognitive processing.

Finally, our cognitive processing variable was based on a self-report questionnaire that subjects answered after the experiment, requiring them to assess their cognitive processing in retrospect. This method allowed us to measure several aspects of cognitive processing, circumventing an overly restrictive definition of the phenomenon (e.g., attention to argument, stereotyping). We were also able to partly validate the measures, looking at their relation with time spent on solving the task. However, as with all self-report measures, we are dependent on subjects' ability and willingness to correctly assess and report their cognitive processing. Thus, we encourage future research to continue exploring how best to capture the various aspects of cognitive processing with other means than self-report.

6. Concluding remarks

The valence-based approach has long dominated the study of incidental emotions and JDM outcomes. By going beyond this approach, we discovered that aspects other than valence are important to explain emotional experience and its effects on cognitive processing. Findings highlight the importance of arousal, and motivate for the inclusion of cognitive appraisals in future studies. The study further demonstrates that both physiological and subjective aspects are essential to emotional experience. To our knowledge, this study is the first of its kind to explore the interplay between physiological arousal and cognitive appraisals. Overall, our study may represent one step towards an integration of the field, and we can only hope that others will continue to expand the understanding of emotion and its effects beyond the valence-based approach.

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Preliminary Thesis Report

The Moderating Role of Gender in the Relationship between Incidental Emotions and Cognitive Processing: A test of Competing Hypotheses

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Content

Abstract

This preliminary thesis report provides a review of relevant literature for our final master thesis. By adopting a competing hypotheses design, we seek to investigate how incidental emotions influence cognitive processing, and how gender moderates this relationship. We present two frameworks that may explain these influences. The first framework is based on the concept of core affect (i.e., valence and arousal), and empirical findings indicating gender differences in responses to the same affective stimuli. The second framework is based on theoretical and empirical insights from the appraisal-tendency framework on discrete emotions, and empirical findings indicating gender differences in experiences of discrete emotions. We arrive at two competing sets of hypotheses that both provide explanations of how emotions influence cognitive processing, and the moderating role of gender in this relationship. At the end of the report, we briefly outline how the research question will be investigated with an experimental between-subject research design.

1. Introduction

A profound interest in the interplay between emotions and thinking have emerged within the judgment and decision-making (JDM) field, as scholars have come to realise that our judgments and decisions are not made based on 'cold' cognitive processes alone. According to Schwarz and Clore (2007) the 'hot' aspects of our thinking were rediscovered in the 1980s after having been absent for a long time. Now, decades later, the notion that emotions influence judgments and choices we make is no longer a controversial argument. Our affective states work as sources of information, through affective, bodily and cognitive experiences. These sources are informative regarding our current situation, and we adopt our cognitive processing strategy in order to match our perceptions of situational requirements (Schwarz, 2002).

A topic largely absent in the JDM literature on emotions is gender differences (for an interesting exception see Fessler, Pillsworth, and Flamson, 2004). This absence is apparent in a recent literature review on emotions and decision-making in which gender is not mentioned once (Lerner, Li, Valdesolo, & Kassam, 2015). This is surprising, as several studies in the psychological field have found differences in how men and women perceive, experience and respond to emotional stimuli (e.g., Brody, Lovas, & Hay, 1995; Stevens & Hamann, 2012). These findings create reason to believe that the same emotional stimuli may have differential effects on JDM outcomes for men and women. Thus we aim at exploring whether and how gender moderates the influence of emotions on cognitive processing.

Emotions differ from other affective states (e.g., moods) in that they have "an identifiable referent, a sharp rise in time, limited duration, and often high intensity" (Schwarz & Clore, 2007, p. 385). Thus their effects are relatively short-lived. Nevertheless, an important assumption underlying our research question is incidental emotions. Unlike *integral emotions*, which arise from the judgment or choice at hand (Damasio, 1994), *incidental emotions* are not related to stimuli in the current situation, but "pervasively carry over from one situation to the next, affecting decisions that should, from a normative perspective, be unrelated to that emotion" (Blanchette & Richards, 2010, p. 803). This carryover process denotes that an emotion triggered in one situation automatically elicits a motive to act on this emotion towards targets unrelated to the source of the emotion. Whereas effects of integral emotions can operate at both conscious and unconscious levels, effects of incidental emotions typically occur without our awareness (Lerner et al., 2015). Incidental emotions influence people's reasoning processes, and "have a variety of rational and irrational influences on judgements, decisions, and behaviours" (Pham, 2007, p. 157). By applying a competing hypotheses design, we aim at investigating how incidental emotions influence cognitive processing, and how men and women differ in cognitive processing as a function of differential responses to the same affective stimuli.

2. Key Concepts and Conceptual Models

Before we proceed with a more comprehensive literature review and hypotheses, we will give a short outline of main concepts, and how they relate to cognitive processing to constitute two competing conceptual models.

Cognitive processing. Within literature on cognitive processing, dual-process theories have become the dominant perspective (e.g., Epstein, 1994; Kahneman, 2003; Mukherjee, 2010; Stanovich and West, 2000). This framework distinguishes between two basic ways individuals process information and make judgments and decisions. The first, an *intuitive processing mode,* is quick and spontaneous and associated with heuristic and effortless decision-making, whereas the second, an *analytical processing mode,* is slow and deliberate and associated with systematic and careful analysis. The intuitive mode makes relatively low cognitive demands, as opposed to the analytical mode, which makes demands on individuals' cognitive capacity and requires high mental effort. Research has repeatedly shown that emotions influence how individuals process information (for reviews see for example Schwarz and Clore, 2007). However, findings have been inconsistent and mechanisms behind this influence are not yet clear.

Core affect and discrete emotions. In pace with increasing awareness of the central role emotions play, several attempts to conceptualise the structure and influence of emotions have emerged. A crude distinction can be made between approaches categorising emotions predominantly along the dimensions of valence and arousal (e.g., Russell, 1980) and approaches arguing for a number of separate and distinctive emotional states that differ in many aspects beyond valence and arousal (e.g., Ekman, 1992). A convergence between different approaches can be observed over time as scholars have tried to integrate concepts and empirical findings, one example being Russell's (2003) attempt to distinguish between *core* *affect*, represented by valence and arousal, and *emotional episodes* in which psychological processes other than affect are added. Russell (2003) defines core affect as “a neurophysiological state that is consciously accessible as a simple, nonreflective feeling that is an integral blend of hedonic (pleasure–displeasure) and arousal (sleepy–activated) values” (p. 147). In our first conceptual model (figure 1), valence and arousal play a crucial role in explaining how core affect influences cognitive processing, and how gender differences emerge.

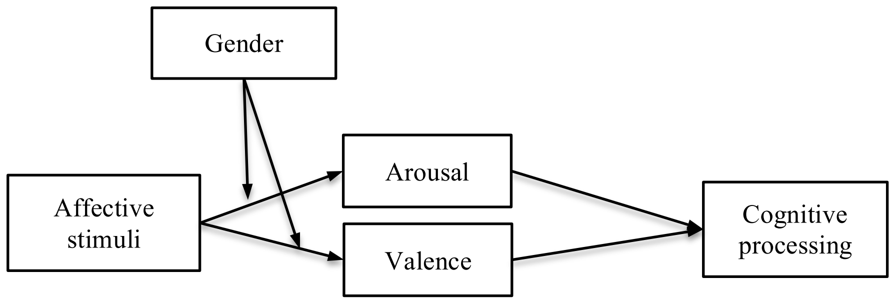

Figure 1: Conceptual model 1

Emotional episodes (i.e. discrete emotions) are at the core of our second conceptual model, constituting a competing perspective on influences of emotions and gender on cognitive processing. Lerner et al. (2015) note that although most literature on emotions in the JDM field has taken a valence-based approach, the field has begun to realise that valence and arousal may not be sufficient to fully explain the influence emotions can have on judgments and decisions. Several authors (e.g., Smith & Ellsworth, 1985; Lerner & Keltner, 2000; Moors, 2013) point to the importance of cognitive appraisals for understanding the basis of emotional experience and influence. We define discrete emotions in line with this perspective as responses “to ongoing, implicit appraisals of situations with respect to positive or negative implications for one’s goals and concerns” (Schwarz & Clore, 2007, p. 385) The main idea is that different emotions are distinguishable from each other based on distinct appraisal patterns. Thus, this perspective is positioned between the two approaches outlined above; it realises the uniqueness of different emotions, but argue that they can be classified along a limited number of dimensions. These appraisals play a crucial role in our second conceptual model (figure 2). In line with this perspective on emotions, incidental emotions influence cognitive processing through their influence on how people perceive the decision-making situation, i.e., through people's appraisal tendencies (Lerner & Keltner, 2000).

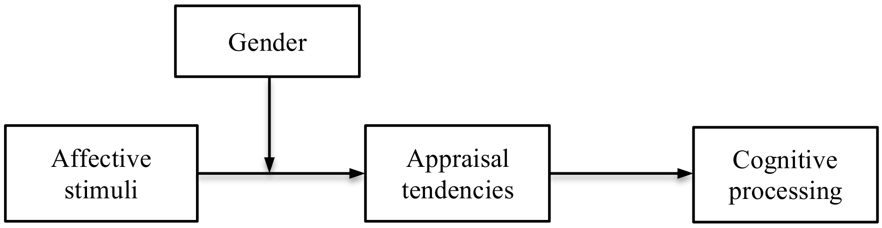

Figure 2: Conceptual model 2

2. Literature Review and Hypotheses

2.1. Core affect, Gender, and Cognitive Processing

Russell's (2003) definition of core affect builds on *the circumplex model of affect* (Russell, 1980), viewing emotional experience as comprised by two interrelated dimensions of *valence* (pleasure-displeasure) and *arousal* (sleepy-activated). In the pleasure-displeasure dimension, the emotion is the individual's assessment of one's current condition, and its value can be positive or negative. In the arousal dimension, the emotion is the individual's sense of energy and mobilization, and its values can be high or low. Core affect has frequently been included in models to explain cognitive processing of individuals, and a large body of research have documented that emotions have influential impact on cognitive processes (e.g., Forgas, 1995; Schwarz & Clore, 2007). The relationship between core affect and cognitive processing may vary with gender, as the same emotional stimuli have shown to elicit different levels and arousal and valence in women and men (Wrase et al., 2003). We will further elaborate on these components to develop hypotheses about how core affect influences cognitive processing, and the role of gender within this relationship.

2.1.1. Core Affect and Cognitive Processing

Valence and cognitive processing. *The affect infusion model (AIM)* explains "the process whereby affectively loaded information exerts an influence on and becomes incorporated into the judgemental process, entering into the judge's deliberations and eventually colouring the judgemental outcome" (Forgas, 1995, p. 39). The model assumes that affective states interact with cognitive processes as they influence which cognitive constructs are available for use in constructive processing of information. Individuals tend recall information congruent with their current feelings (Bower, 1981), and use how they feel about a target as basis for their judgements (Schwarz & Clore, 1988). Based on the *affect-as-information hypothesis* (Schwarz, 1990), emotions become a direct basis for decision-making. Unpleasant emotions signal that the situation is problematic and threatening, which require the individual to process information more carefully, thereby fostering analytical processing (Schwarz, 2000). Pleasant emotions do not signal the same threat and problems, making individuals attend more to pre-existing knowledge structures and routines, which tend to trigger intuitive processing (Blanchette & Richards, 2010).

Pleasant emotions are empirically related to individuals being more prone to the fundamental attribution error, i.e., overestimation of others' actions being driven by personal disposition rather than situational factors (Forgas, 1998), more top-down reasoning (Oaksford, Morris, Grainger, & Williams, 1996), and the use of a less thorough processing mode (e.g., Batra & Stayman, 1990). Thus, individuals' emotional state come to influence their judgment, in terms of which cognitive processing mode they are likely to adopt, and ultimately also their decision-making. Despite some contradictory findings (e.g., Isen, Rosenzweig, and Young (1991) found that positive affect promotes systematic processing), the main stream of research on cognitive affect has concluded that negative affect is related to analytical processing and that positive affect is related to intuitive processing (Schwarz & Clore, 2007). Based on the above findings, we can hypothesise:

H1a: Valence will mediate the relationship between affective stimuli and cognitive processing. Participants in the negative affect condition will display higher levels of analytical processing than participants in the positive affect condition.

Arousal and cognitive processing. Although not synonymous, arousal and stress are closely related. Stress can be defined as "a state of high general arousal and negatively tuned but unspecific emotion, which appears as a consequence of stressors (i.e., stress-inducing stimuli or situations) acting upon individuals" (Boucsein, 2012, p. 318). Thus, it follows from the definition that arousal is an essential part of stress. Arousal is a bodily experience that informs the individual about its current condition (Schwarz & Clore, 2007).

Acute and severe stress has shown to impair cognitive functions of the prefrontal cortex (PFC), and switch control of behaviour and emotion to more primitive brain circuits, including the amygdala (Arnsten, 2009). Under conditions of psychological stress, the amygdala activates stress pathways, which evokes high levels of dopamine and noradrenaline. Whereas this impairs the PFC regulation, the amygdala function is strengthened. Other neural regions activated under such conditions include basal ganglia, ventromedial prefrontal cortex, lateral temporal cortex, and dorsal anterior cingulate cortex. Human attention "switches from thoughtful 'top-down' control by the PFC that is based on what is most relevant to the task at hand to 'bottom-up' control by the sensory cortices" (Arnsten, 2009, p. 4). This switch in the brain's responses can also be seen as a switch from the C-system, i.e., the reflective system, to the X-system, i.e., the reflexive system (Lieberman, 2007). As the brain's responses switch from slow and thoughtful regulation by the PFC to the more rapid and reflexive responses of the amygdala, individuals' working memory and reasoning abilities are impaired (Pham, 2007). Following Lieberman's (2007) review, the X-system and the C-system correspond roughly to the intuitive and the analytical processing modes, respectively. Based on this, we hypothesise:

H1b: Arousal levels will mediate the relationship between affective stimuli and cognitive processing. Arousal will be negatively related to analytical processing.

2.1.2. Gender Differences in Core Affect and Cognitive Processing

Gender differences in cognitive processing are related to both valence (e.g., Stevens & Hamann, 2012) and arousal (e.g., Bradley, Codispoti, Sabatinelli, & Lang, 2001). Gender differences in core affect have been attributed to genotypic differences in the nervous system, as the neural networks used by women and men differ when processing emotional information (Hofer et al., 2006). Women have been found to respond more strongly to negative emotional stimuli, in contrast to men who tend to respond more strongly to positive emotional stimuli (Stevens & Hamann, 2012). Whereas women display activation in the left amygdala during negative emotional conditions, the same holds for men in positive emotional conditions. Hence, there is meta-analytical evidence for the notion "that the amygdala, a key region for emotion processing, exhibits valence-dependent sex differences in activation to emotional stimuli" (Stevens & Hamann, 2012, p. 1578).

Women show higher levels of arousal than men when they experience a negative emotional state, an effect that is stronger when they are presented with threatening stimuli (Bradley et al., 2001). Furthermore, women show stronger coupling between ratings of unpleasantness and arousal than men, and rate the most unpleasant pictures as more arousing than men (Bradley et al., 2001). For pleasantness, there was a tendency for men to show stronger positive correlation between ratings of pleasure and arousal, and for men to find the most pleasant pictures more arousing than women. Overall, women have shown to be more reactive to unpleasant pictures and found these pictures more arousing, compared with men. Regarding pleasant pictures, the results are more inconsistent. Whereas Bradley et al. (2001) found men to have higher arousal than women when presented with positive stimuli, Johnsen, Thayer, and Hugdahl (1995) found higher arousal levels in women also for positive stimuli. Nevertheless, based on the main stream of research we hypothesise:

H2a: In the negative affect condition, women will respond more negatively and show higher levels of arousal than men.

H2b: In the positive affect condition, men will respond more positively and show higher levels of arousal than women.

Based on all of the above, we can hypothesise the following about gender differences in cognitive processing:

H2c: In the negative affect condition, men will display higher levels of analytical processing than women.

H2d: In the positive affect condition, women will display higher levels of analytical processing than men.

2.2. Discrete Emotions, Gender, and Cognitive Processing

In an attempt to expand our understanding of incidental emotions and their effects, Lerner and Keltner (2000, 2001) point to the importance of examining discrete emotions and cognitive appraisals underlying these. *The appraisal-tendency framework* (ATF) postulates that incidental emotions predispose individuals to appraise future situations in certain ways, with consequences for JDM outcomes. Angie, Connelly, Waples, and Kligyte (2011) found support for this perspective in their meta-analysis. Overall, discrete emotions were found to have moderate to large effects on JDM outcomes in ways that could be explained by predictions derived from ATF.

The significance of looking beyond core affect, and to cognitive appraisals, is also supported by findings suggesting that emotions of the same valence and arousal differ in essential ways, including different depths of processing, facial expressions, brain hemisphere activation, central nervous activity, autonomic responses and antecedent appraisals (Lerner et al., 2015). Emotions of the same valence have shown to produce differential effects on cognitive processing, and emotions of different valence have shown to produce similar effects (e.g., Tiedens & Linton, 2001; Lerner & Tiedens, 2006; Bodenhausen, Sheppard, & Kramer, 1994). Bodenhausen et al. (1994) found that sadness and anger had opposite effects on cognitive processing, with angry individuals relying more on stereotypes and heuristic cues. In a related study, Bodenhausen, Kramer, and Süsser (1994) found that happy individuals made more stereotypic judgments (i.e., based on intuitive processing), indicating similar effects of anger and happiness.

Differences between discrete emotions also persist when arousal is taken into consideration. Anger and fear are similar in both arousal and valence, and should, according to the circumplex model of affect (Russell, 1980), be similarly related to judgment and decisions. However, angry and fearful individuals make opposite responses on risk perception. Angry individuals tend to make optimistic judgments of future events, whereas fearful individuals make pessimistic judgments (Lerner & Keltner, 2001). Moreover, happy and angry individuals have been found to make similar judgments, also contradicting the valence-based approach (Lerner & Tiedens, 2006). We will further elaborate on ATF in order to develop hypotheses about how discrete emotions influence cognitive processing, and how gender may moderate these effects.

2.2.1. The Appraisal-Tendency Framework and Cognitive Processing

ATF specifies six cognitive appraisal dimensions, based on analyses performed by Smith and Ellsworth (1985): Pleasantness, anticipated effort, certainty, attentional activity, self-other responsibility/control, and situational control. Smith and

Ellsworth (1985) found that "emotions varied systematically along each of these dimensions, indicating a strong relation between the appraisal of one's circumstances and one's emotional state" (p. 813). The importance of cognitive appraisals in emotional experience is a common argument among contemporary emotion theorists (Power & Dalgleish, 2007). What makes ATF novel as an analytic framework is the argument that these dimensions are not only relevant for classifying emotional experience, but also for making predictions about how incidental emotions influence JDM outcomes. Lerner and Keltner (2000, 2001) argue that each emotion can potentially influence individuals to perceive new situations in ways that are similar to the cognitive appraisals that caused the emotion:

> Drawing on evidence that each specific emotion (a) is defined by a set of central dimensions and (b) directs cognition to address specific problems or opportunities, we hypothesise that each emotion activates a cognitive predisposition to appraise future events in line with the central-appraisal dimensions that triggered the emotion – what we call an appraisal tendency. In short, appraisal tendencies are goal-directed processes through which emotions exert effects on judgement and choice until the emotion-eliciting problem is resolved. (Lerner & Keltner, 2000, p. 477)

In short, the carry-over process of incidental emotions works by colouring the perception and interpretation of new stimuli through a sequence of appraisal-emotion-appraisal tendency.

A key argument in ATF is that emotions influence judgment and decision-making beyond valence and arousal (Lerner & Keltner, 2000), which findings above illustrate. Tiedens and Linton (2001) argue that cognitive components of emotions become particularly important when investigating cognitive consequences of emotions, such as cognitive processing. ATF offers opportunities to make specific predictions on how emotions influence a specific outcome, in this case cognitive processing, by analysing appraisal tendencies on dimensions relevant for this outcome. Lerner and Keltner (2001) argue that certainty and control are especially relevant for JDM outcomes. We argue that anticipated effort also is important when the outcome variable is cognitive processing.

Certainty can be defined as "the degree to which future events seem predictable and comprehensible (high) vs. unpredictable and incomprehensible (low)" (Lerner & Keltner, 2000, p. 479). Tiedens and Linton (2001) found that emotions characterised by certainty appraisals promoted higher levels of intuitive processing in subsequent situations, compared to emotions associated with uncertainty appraisals. Bagneux, Font, and Bollon (2013) found similar results. Participants induced with uncertainty emotions (fear and sadness) engaged more in analytical processing, compared to participants induced with certainty emotions (anger, happiness, disgust), who engaged more in intuitive information processing. Based on this, we can expect individuals that perceive low certainty to engage in higher levels of analytical processing in order to increase the predictability and comprehensibility of the situation, whereas individuals who perceive high certainty do not feel the need to analyse the situation and will be more intuitive in their processing.

C*ontrol* is defined as "the degree to which events seem to be brought about by individual agency (high) vs. situational agency (low)" (Lerner & Keltner, 2000, p. 479). Relating this to cognitive processing, we can expect that individuals who perceive low control will engage in analytical processing in order to try to restore a comfortable level of control (even if this is not possible from an objective point of view). Individuals who perceive high control will not feel the need to do so, and thus will be more intuitive in their processing.

Finally, *anticipated effort* concerns "the degree to which physical or mental exertion seems to be needed (high) vs. not needed (low)" (Lerner & Keltner, 2000, p. 479). As previously noted, analytical processing demands mental effort from individuals. Based on this, we can expect that individuals who anticipate low effort will be more intuitive as the situation signals to them that high mental effort is not needed. Equally, individuals who anticipate high effort will engage more in analytical processing to match their perception of situational demands. Based on this we hypothesise:

H3: Appraisal tendencies will mediate the relationship between affective stimuli and cognitive processing.

H3a: Perceived certainty will be negatively related to analytical processing.

H3b: Perceived control will be negatively related to analytical processing.

H3c: Perceived anticipated effort will be positively related to analytical processing.

2.2.2. Gender Differences in Discrete Emotions and Cognitive Processing

As noted in the section about core affect, several studies from neuropsychology have found differences in how men and women respond to emotional stimuli. Interestingly, Wrase et al. (2003) found these differences in brain activation also when male and female participants had similar levels of valence and arousal. Evidence on gender and emotions from the JDM field is scarcer, but some studies have found gender differences in discrete emotions, especially in the case of negative emotions. Brody et al. (1995) found that stimuli expected to induce anger in participants, elicited more fear (in addition to anger) in female participants than in male participants. Lerner, Gonzalez, Small, and Fischhoff (2003) found that men and women reported different emotions after the same negative emotional stimuli. Similar to the above, women reported more fear and less anger than men. They argue that these differences in self-reported emotions could explain a large portion of the gender differences they found in risk perceptions (men estimated lower risk than women). Consistent with the assumptions of ATF outlined above, the gender differences in risk perceptions may be attributed to female appraisals corresponding to fear, and male appraisals corresponding to anger.

Gender differences in discrete emotions are also consistent with a functionalist perspective on emotions, in which emotions are seen as having had adaptive value in fundamental life-tasks (Ekman, 1992). Different emotions may be appropriate for men and women in the same situation because of gender differences in biological attributes as well as socially prescribed roles. Fessler et al. (2004) argue that such differences are particularly prevalent when it comes to anger, with male anger being more adaptive in an evolutionary perspective. It must be noted that there are several studies that have not found gender differences, or that have not commented on whether they have found such differences. One possible reason for this is that several studies have asked participants to recall episodes in which they felt a certain emotion, rather than having exposed them to the same external stimuli.

Based on the above evidence of gender differences in emotional experience we assume that the same negative emotional stimuli may trigger differences in discrete emotions in men and women. We have been unable to uncover consistent findings suggesting similar differences with regards to positive emotional stimuli, and therefore we do not assume any gender differences in the positive affect condition here.

H4a: In the negative affect condition, men will report higher levels of anger compared to women, whereas women will report higher levels of fear compared to men.

H4b: In the positive affect condition, men and women will report similar feelings of happiness.

Based on the ATF framework, we can assume that the gender differences in emotional experience lead to different appraisal tendencies for men and women in the subsequent decision-making situation, leading to differences in cognitive processing. Table 1 depicts cognitive appraisals underlying the emotions we have identified above, appraisal tendencies they trigger, and consequences for cognitive processing. We have chosen to focus only on the dimensions identified as relevant above (see Smith and Ellsworth (1985) for a thorough description of all dimensions).

Table 1: *Emotions and their corresponding appraisal tendencies*

	Negative affect condition		**Positive affect condition**
	Fear	*Anger*	*Happiness*
Certainty	Low	High	High
Anticipated effort	High	Medium	Low
Control	Low	High	High
Pleasantness	Low	Low	High
Appraisal Tendency	Perceive events as uncertain and unpredictable and not under human control, demanding high physical or mental effort	Perceive events as certain and predictable and under human control, demanding neither high or low physical or mental effort	Perceive events as predictable and under human control, demanding little physical or mental effort
Influence on cognitive processing	Analytical processing	Intuitive processing	Intuitive processing

Table 1 depicts cognitive appraisals underlying the emotions we have identified above, appraisal tendencies they trigger, and consequences for cognitive processing. We have chosen to focus only on dimensions identified as relevant above (see Smith and Ellsworth (1985) for a thorough description of all dimensions). Relating this to gender differences described above, we can predict:

H4c: In the negative affect condition, women will display higher levels of analytical processing than men.

H4d: In the positive affect condition, both men and women will display intuitive processing.

2.3. Competing Hypotheses

The review above show that the two frameworks we have presented predicts opposite effects of emotions and gender on cognitive processing. Thus, they can be viewed as competing sets of hypotheses that both provide explanations of how emotions influence cognitive processing, and the moderating role of gender in this relationship.

3. Methodology

The research question will be investigated with an experimental between-subject research design. We will conduct a laboratory experiment consisting of two conditions: positive and negative affect. Each round will host five participants randomly assigned to one of the two conditions. Our sample will consist of students recruited from BI Norwegian Business School and the University of Oslo. We aim at reaching a minimum of 120 participants in order to reach a sufficient number of men and women in the two conditions.

Before we start the experiment, participants will be connected to *the sudo logger* for measurement of skin conductance response (SCR), in order to set a baseline. The SCR will be used to measure arousal levels of participants throughout the entire experiment. The experiment will start by showing participants a picture (either positive or negative depending on condition) from the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 2008), followed by the self-assessment manikin (SAM) of valence and arousal (developed by Lang (1980), cited in Lang et al. (2008)). In order to measure discrete emotions, participants will be asked to (a) indicate which emotions they are experiencing by choosing from a list of alternatives, and (b) indicate the intensity of the emotions they are experiencing on a scale from 1 (only slightly) to 5 (extremely). The participants will then be presented with the *Asian disease problem* (gain frame) developed by Tversky and Kahneman (1981). The decision-making task will be followed by a cognitive processing questionnaire measuring the degree of intuitive and analytical processing during the task (Sinclair, 2004; Bakken & Haerem, 2011), and a shortened version of Smith and Ellsworth's

(1985) appraisal questionnaire measuring perceived certainty, control, and anticipated effort on a scale from 1 (not at all) to 11 (extremely).

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