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Individual Differences in Decision-Making and Emotions: A Study of Alexithymia Using the Columbia Card Task

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Abstract

Making effective decisions requires a balance between rational thinking and emotional processing. Optimal decision-making approaches involve carefully analyzing available information to make informed and advantageous choices. This study investigates how people's ability to identify, process, and express emotions (alexithymia) relates to their decision-making in different emotional contexts. We used the Hot and Cold versions of the Columbia Card Task (CCT) to evaluate how participants make decisions. By analyzing their decisions as a function of their alexithymia levels and three manipulated game parameters (loss probability, loss amount, and gain amount), we discovered that people with higher levels of alexithymia had reduced sensitivity to losses, especially in the Hot version of the CCT. These results indicate that people with alexithymia may underestimate losses when making decisions involving emotional processing, leading to biased outcomes. Our findings have important implications for understanding and addressing risk-taking behaviour in individuals with heightened alexithymia.

Keywords

Alexithymia, Decision-making, risk-taking, Columbia Card Task (CCT), sensitivity to loss probability, sensitivity to reward, sensitivity to loss, information processing

Summary for Lay Audience

Making good decisions involves finding a balance between our emotions and logical thinking. It is essential to analyze the available information to make smart choices carefully. At the same time, our emotions can serve as helpful guides toward favourable decisions and away from unfavourable ones. In this study, we wanted to understand how a person's ability to understand and express emotions (known as alexithymia) relates to their decision-making in situations requiring varied emotional processing. To investigate this, we asked participants to complete the Columbia Card Task (CCT), which had two versions: a "Hot" version that involved emotional processing and a "Cold" version that focused on deliberative thinking. We looked at how participants made decisions based on their alexithymia levels and three factors we manipulated in the game: the chances of losing, the amount of loss, and the amount of gain. We found that people with higher levels of alexithymia were less sensitive to losses in the "Hot" version of the task. This means they tended to underestimate potential losses when making decisions in emotionally charged situations, leading to greater risk-taking. These findings are important because they help us understand how difficulties in understanding and expressing emotions can influence decision-making, particularly when emotions are involved. By recognizing this relationship, we can better understand and address risky behaviour in individuals with heightened alexithymia and those with emotional processing difficulties.

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Emotions encompass complex physiological and psychological responses that emerge in reaction to internal or external stimuli, such as thoughts, events, or environmental cues (Lazarus, 2006; Sifneos, 1973, 1975). Automated processes do not solely determine our emotions but are also affected by our thoughts and perceptions (Lazarus, 2006). These mental processes are essential in helping us comprehend and interpret events that occur in our lives based on our evaluations. Our emotions are accompanied by distinct subjective feelings such as happiness, sadness, fear, anger, or surprise, expressed through observable manifestations like facial expressions, body language, and physiological changes.

Deliberative and emotional processes do not conflict with one another but are intricately related (Damasio, 2005; Kahneman, 2011; LeDoux, 1990). Indeed, emotions play a fundamental role in shaping our perceptions, motivations, and behaviours, influencing our interactions with the world (see Lerner et al., 2015). Ultimately, emotions are catalysts for action, instigating and guiding our behaviour. They can alert us to potential dangers or opportunities and guide us toward decisions that align with our values and goals (Colautti et al., 2022; Lazarus, 2006). For example, feeling fear in a dangerous situation can prompt us to avoid potential harm, while feeling excited about an opportunity can encourage us to pursue it. Hence, the Latin etymology of the term 'emotions'—'*emovere,*' meaning '*to move out*' (Van Der Kolk, 2014, p. 75).

Individuals vary in their experience of emotions, highlighting the complexity of the processes involved in detecting, identifying, understanding, and labelling emotions. These processes are crucial for individual and social adaptation, encompassing developmental, experiential, and cognitive factors (Koole & Rothermund, 2019). Some people are more emotionally sensitive and responsive than others, easily able to recognize and understand their emotions and those of others. On the other hand, some individuals struggle with identifying their feelings or expressing them effectively. These emotional differences affect how we interact with our environment and impact our mental health, relationships, and overall well-being. By studying these variations, we can develop better assessment methods and interventions for those who experience difficulties with their emotional experiences. This can ultimately improve outcomes for individuals facing emotional challenges.

Alexithymia refers to individual differences in identifying, processing, and expressing emotions (Luminet et al., 2018; Nemiah et al., 1976). Peter Sifneos, a psychotherapist, first noticed these difficulties while treating psychosomatic patients in the 1970s. He observed that many struggled to understand and communicate their feelings and recognize emotions in others. These challenges were closely linked to their psychological and physical symptoms. To describe this condition, Sifneos combined three Greek words: '*a*' (meaning lack), '*lexis*' (meaning word), and '*thymos*' (meaning mood or emotion). Consequently, 'alexithymia' directly translates to 'lack of words for emotions.'.

As research on alexithymia has advanced, our understanding of this condition has grown to recognize that individuals can exhibit varying degrees of difficulty (Preece et al., 2017; Preece et al., 2020). Some may face mild emotional awareness, processing, and expression challenges, while others may experience more significant deficits (Mattila et al., 2010; Parker et al., 2008). However, the precise definition of alexithymia and its core features subject to inclusion in its description remain topics of significant debate (see Taylor & Bagby, 2021). Alexithymia encompasses individual differences in cognitive aspects of emotional experience, such as difficulties in identifying and describing emotions (Nemiah et al., 1976; Sifneos, 1975; Bagby et al., 1994a; Bagby et al., 1994b), as well as variations in the affective components of emotions, including reduced physiological affect (Bermond et al., 2007; Vorst & Bermond, 2001). Consequently, the complex nature of this condition may result in inconsistencies in its understanding, assessment, and treatment of individuals facing alexithymia-related problems. Despite its limitations, alexithymia has proven to be a highly valuable topic of study. Its remarkable growth of approximately 13% in yearly publications, with over 80,000 references on Google Scholar to date. This surge in scholarly interest starkly contrasts the limited number of alexithymia-related publications available in the 1970s when the condition was initially introduced (Luminet et al., 2018, pp. xii-xiii). The substantial body of research reflects the widespread acknowledgment among researchers and clinicians of the significant implications that alexithymia holds for mental health and overall well-being. The relationship between alexithymia and decision-making is a topic of considerable interest. Decision-making is a fundamental aspect of human cognition and behaviour (Shadlen & Kiani, 2013). It encompasses a series of cognitive processes to assess options, consider potential outcomes, and select the most suitable action. The unique way individuals approach decision-making significantly impacts various aspects of their lives, such as relationships, career paths, and lifestyle. This, in turn, affects personal happiness, organizational success, and societal well-being (Bogacz, 2007; Kahneman, 2011).

Many psychological disorders manifest distortions in individuals' decision-making processes. These same disorders frequently co-occur with a notable prevalence of alexithymia. Approximately 40-55% of individuals with substance use disorder (SUD) and gambling disorder exhibit heightened levels of alexithymia (Hamidi et al., 2010; Luminet et al., 2018, pp. 158-163; Marchetti et al., 2019; Palma-Álvarez et al., 2021; Thorberg et al., 2008; Thorberg et al., 2009; Thorberg et al., 2011). This contrasts strikingly with the lower observed rate of 10% in the general population (Luminet et al., 2018, pp. 158-173). Interestingly, elevated alexithymia in individuals with behavioural addictions, such as pathological gambling, suggests that it is not solely attributable to drug toxicity in those with addictions (Hamidi et al., 2010). Furthermore, alexithymia in patients with SUDs is a state phenomenon that is closely intertwined with other vulnerability factors for addiction, including reward sensitivity and is associated with the severity of addiction symptoms, drug cravings, and overall quality of life (de Haan et al., 2012; de Haan et al., 2014; Morie et al., 2016). Similar associations occur among individuals with gambling disorders (Bonnaire & Baptista, 2019; Gaetan et al., 2016).

Deliberative decision-making involves the thoughtful consideration and logical analysis of available options to arrive at a well-informed choice (Bogacz, 2007; Prendergast, 1993). This approach follows a systematic process of problem definition, information gathering, alternative assessment, and decision-making based on expected utility. On the other hand, optimal decision-making aims to identify the most advantageous choice by maximizing overall value or efficiency. Given the available alternatives and constraints, the goal is to achieve the best possible outcome. While deliberative decision-making often leads to optimal choices, it's important to note that achieving true optimality can be challenging due to subjective factors and contextual limitations (van der Meer et al., 2012). Challenges such as accurately assessing situations, generating alternatives, and objectively weighing pros and cons can lead to repetitive decisions that don't align with personal goals. Additionally, difficulties in gathering and processing information, comprehending the consequences of options, and evaluating associated risks can significantly impact decision outcomes. Decision-making processes can also be influenced by impulsive or compulsive behaviours, disrupting the ability to consistently exhibit well-considered decision patterns (Franken et al., 2008). These variations in decision-making underscore the importance of understanding and addressing individual differences to enhance decision outcomes.

By understanding the relationship between emotional experiences and decision-making processes, we can develop diverse prevention and intervention techniques for a broader range of individuals, including those with subclinical levels of psychopathology. Indeed, alexithymia is associated with increased risk-taking in various domains, such as legal, sexual, academic, and athletic domains (Barlow et al., 2015; Hahn et al., 2016; Panno et al., 2019). Furthermore, it is also positively correlated with heightened risk-taking tendencies in laboratory decision-making tasks (Aite et al., 2014; Bibby & Ross, 2017; Ferguson et al., 2009; Kano et al., 2011; Manzoor et al., 2021; Scarpazza et al., 2017; Zhang et al., 2017). These findings highlight the pervasive connection between emotional experiences and decision-making processes, extending to individuals without clinically diagnosed disorders. We must better enhance our knowledge of its nature to understand alexithymia and its unique variations in emotional experiences. Additionally, investigating the link between individual differences in emotional experiences and decision-making behaviours is crucial. Therefore, exploring the associations between these individual differences and different aspects of decision-making across the range of alexithymia presentations becomes vital in understanding how they impact broader health outcomes.

Advancing the Field and Addressing Concerns

Alexithymia Measurement and Operationalization

Although progress has been made in understanding alexithymia, lack of agreement on its definition has led to diverse methodologies for assessing and establishing criteria. This divergence has impeded comprehensive understanding of the relationship between alexithymia and decision-making, leaving a critical gap in our knowledge of the underlying mechanisms. Additionally, this lack of alignment obscures the connection between individual emotional experiences and their influence on decision-making, making this essential relationship less transparent.

The 20-Item Toronto Alexithymia Scale

Numerous self-report questionnaires and interview-based measures exist that assess and operationalize alexithymia. Among these measures, the 20-Item Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994a, 1994b) stands out as the most extensively utilized and frequently employed tool in the field (Luminet et al., 2018, pp. 17-32). The TAS-20 is a 20-item self-report questionnaire that operationalizes alexithymia based on three dimensions:

The difficulty identifying feelings (DIF) subscale measures individuals' difficulty recognizing and distinguishing emotions (Bagby et al., 1994a). People with high scores on the DIF subscale may have trouble distinguishing between different feelings or recognizing the specific emotions they are experiencing. They might also struggle to identify the physical sensations accompanying their emotions, undermining their ability to recognize their emotional states.

The difficulty describing feelings (DDF) subscale assesses individuals' difficulty verbally expressing or communicating their emotions to others (Bagby et al., 1994a). Individuals with high scores on the DDF subscale may find it challenging to find the right words to describe their emotional experiences or to share their feelings with others. This can lead to misunderstandings in interpersonal relationships and hinder emotional support and connection with others.

Finally, the externally oriented thinking (EOT) subscale measures the tendency of individuals to focus on external events and details rather than their internal emotional experiences (Bagby et al., 1994a). People with high scores on the EOT subscale may prefer discussing factual information rather than exploring their emotions or engaging in introspection. This externally oriented cognitive style contributes to the difficulties experienced by individuals with high alexithymia in recognizing and processing their feelings.

The subscales DIF, DDF, and EOT each comprise seven, five, and eight items, respectively (Bagby et al., 1994). Respondents rate each item on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). The total score is between 20 and 100, with higher scores indicating greater alexithymia. While cut-off scores differ depending on the research or clinical context, a score of 61 or higher generally indicates high alexithymia severity (Luminet et al., 2018, p. 17). However, some authors (Bagby et al., 1997), who argue that it oversimplifies the complexity of the construct, have criticized using a single-cut score to categorize individuals into different levels of alexithymia severity. Therefore, the preferred approach is to use the full-scale score, given the multidimensional nature of alexithymia (Luminet et al., 2018; Parker et al., 2008).

Psychometrics. The TAS-20 is a convenient and widely used tool in research due to its ease of administration and scoring. It was developed based on Sifneos' (1975) definition of the alexithymia construct and later refined by Graeme J. Taylor, Michael Bagby, and James D. A. Parker in the late 1980s and early 1990s. The TAS-20 has demonstrated relative stability in scores across various time intervals and samples (Bagby et al., 1994a; Berhotz & Hill, 2005; Besharat, 2008; Hiirola et al., 2017; Luminet et al., 2001; Mikolajczak & Luminet, 2006; Sakkinen et al., 2007). It is extensively used in research to explore the relationship between alexithymia and various psychological and physical health outcomes (see Luminet et al., 2018; Taylor et al., 1999).

Construct Validity. The construct validity of the TAS-20 is strong and robustly consistent (Luminet et al., 2018, pp. 17-20). Moreover, the underlying three-factor structure (DDF, DIF, and EOT) is stable and repeatedly established in clinical and non-clinical samples (e.g., Bagby et al., 1994a; Parker et al., 2003). Nevertheless, there have been several proposed changes to the conceptualization and measurement of the alexithymia construct as defined by Sifneos (1975; Nemiah et al., 1976) and the TAS-20 (Bagby et al., 1994a).

During the latter half of the 1990s, a team of Dutch researchers extended the definition of alexithymia to include cognitive and affective aspects to capture the multidimensional nature of the construct better (see Vorst & Bermond, 2001). This broader conceptualization of alexithymia was operationalized in developing the 40-item self-report Bermond-Vorst Alexithymia Questionnaire (BVAQ; Vorst & Bermond, 2001). The scale consists of five subscales: Identifying (IDEN), Verbalizing (VERB), Analyzing (ANAL), Fantasizing (FAN), and Emotionalizing (EMO). The first three subscales assess the same components of the alexithymia construct as the DIF, DDF, and EOT subscales of the TAS-20. Notably, though, the BVAQ adds two additional subscales. The EMO subscale assesses "the degree to which someone is emotionally aroused by emotion-inducing events" (p.417), and the FAN subscale assesses deficits in one's capacity for fantasy and imagination. Factor analytic studies by the authors support a 5-factor model with two higher-order factors: a Cognitive factor (composed of the IDEN and VERB factors) and an Affective factor (composed of the FAN and EMO factors). The ANAL factor, which measures the capacity to reflect on and analyze one's emotions, although correlated with both higher-order factors, is considered part of the Cognitive factor (Vorst & Bermond, 2001; Bermond et al., 2007).

Most noteworthy of these changes was the inclusion of an emotionalizing component in alexithymia. This marked a significant theoretical divergence from the original conceptualization of alexithymia formulated by Sifneos (1975) and the TAS-20 (Bagby et al., 1994a). Taylor and Bagby (2021) think this to be a theoretically unsupportable modification to the alexithymia construct, arguing that Vorst and Bermond (2001) overlook the clear distinction between emotions and feelings made by Nemiah et al. (1976) and Sifneos (1975). The former is defined as the visceral and motor-expressive components of effects (e.g., increased blood flow), and the latter as the subjective, cognitive-experiential component (e.g., fear; Taylor et al., 2021). It is unclear to clinicians and researchers whether the additional subscale of the BVAQ is intended to assess differences in physiological arousal or awareness of emotions (i.e., feelings; de Vroege et al., 2018, as cited by Taylor et al., 2021). Sifneos (1975) and Nemiah et al. (1976) emphasized that individuals with alexithymia do experience physiological components of emotion in response to emotional stimuli (e.g., increased heart rate) but struggle with identifying and describing their subjective feelings (e.g., “I am terrified”). While they may acknowledge feeling nervous, sad, or angry, they may have difficulty providing further elaboration or detail when prompted to describe their emotions (e.g., what ‘scared’ feels like). In these cases, the capacity to identify and verbalize one's emotional experiences, as well as the subjective feeling of emotions, is represented by the DIF and DDF components of the alexithymia construct as operationalized by the TAS-20 (Bagby et al., 1994a; Watters et al., 2016).

Interestingly though, an extensive body of contemporary literature demonstrates that there may be a relationship between physiological dysregulation and alexithymia (see Luminet et al., 2017, pp. 291-320). Many studies have found alexithymia to be positively associated with muted physiological responses to emotional stimuli (Cecchetto et al., 2018; Constantinou et al., 2014; Gaigg & Bird, 2018: Kleiman et al., 2016; Nilsonne et al., 2017; Starita et al., 2016). Nevertheless, a dispute is whether these observations justify modifying the alexithymia construct and its associated measurements (i.e., the TAS-20), as proposed by Vorst & Bermond (2001). Indeed, an analogous body of literature exists that reports alexithymia to be both unrelated (Eastabrook et al., 2013; Freund, 2012; Grynberg et al., 2012; Martínez-Velázquez et al., 2017) and positively associated with physiological reactivity to emotional stimuli (Hua et al., 2014; Nandrino et al., 2012). Regrettably, researchers' use of heterogeneous participant populations, statistical techniques, and research methods complicates synthesizing the literature. Moreover, the proposed physiological alexithymia markers, such as physiological blunting and perhaps poor recovery from emotional challenges, are common to depression, anxiety, and other disorders (Luminet et al., 2017, p. 320). Many studies fail to examine the role of these potential moderators or mediators or discuss the role of other confounding variables. This makes it challenging to draw definitive conclusions about whether the alexithymia construct should be modified to capture variability in persons' experience of physical affects.

Despite this controversy, results from several different empirical investigations yield little support for the inclusion of an emotionalizing facet of alexithymia as measured by the BVAQ (Preece et al., 2017; Preece et al., 2020; Taylor & Bagby, 2021; Watters et al., 2016). Network analysis with BVAQ data from a large heterogeneous Multilanguage sample by Watters et al. (2016) fails to support emotionalizing as a distinct component of the alexithymia construct. Moreover, the nodes representing the EMO and FAN facets, which together are supposed to form the higher-order Affective factor, are not connected in facet-level analyses of the network. Preece et al. (2017; 2020) further point out that the EMO items do not differentiate between reactivity for positive emotions and reactivity for negative emotions (which are often negatively correlated dimensions). Three items also assess empathy rather than emotionalizing ('when I see somebody crying uncontrollably, I remain unmoved'). Finally, in contrast to the commonly accepted theoretical model of alexithymia, which proposes a relationship between the facets of the construct, the Cognitive and Affective factors of the BVAQ show little to no correlation. Ignoring issues in validity, this may suggest that reduced emotionalizing and fantasizing may be correlated sequelae of alexithymia rather than part of the construct itself (e.g., Luminet et al., 2004; Taylor et al., 2000).

Overall, although alexithymia may manifest in varying ways across different individuals, including an emotionalizing component as a part of alexithymia is not empirically supported, nor is it congruent with the theoretical origin of the construct. Most alexithymia researchers adhere to the view that alexithymia is a distinct homogeneous construct, and data does indicate that the TAS-20 subscales can offer a more detailed and nuanced understanding of an individual's alexithymic traits (Reise et al., 2013). Subscale scores are less reliable than total scale scores (i.e., total scores are based on more items and better predict an individual's actual score). However, they can still help operationalize different facets of alexithymia (Luminet et al., 2018, p.19). Concerns regarding the potential omission of multidimensional characteristics or variability in the presentation of alexithymia as measured by the TAS-20 are, therefore, likely overstated. Furthermore, the TAS-20 has been translated into 24 languages and validated in various cultural contexts (Taylor et al., 2003). Almost all translations have adequate reliability ($\alpha > .70$), and most replicate the three-factor model proposed by Bagby et al. (1994a; Luminet et al., 2018; pp.18-19). This knowledge can be valuable in clinical settings, research, and cross-cultural investigations. It can aid in customizing interventions, monitoring progress, and understanding the intricate connections between alexithymia and other psychological phenomena. Therefore, even though the research in this field may continue to evolve, the TAS-20 remains the most optimal measure for assessing alexithymia as it is best defined in contemporary research.

Convergent Validity. Multiple studies demonstrate sufficient convergent and concurrent validity for the TAS-20. Estimates vary when comparing the convergent validity of the TAS-20 with other alexithymia measures. However, this is not unexpected given that alexithymia is operationalized and assessed using different measures. Overall, the scale shows significant correlations with other self-report and interview measures of alexithymia, including the Bermond-

Vorst Alexithymia Questionnaire (BVAQ), the Toronto Structured Interview for Alexithymia (TSIA), the Modified Beth Israel Hospital Psychosomatic Questionnaire (M-BIQ), and the Rorschach Alexithymia Scale (RAS). More crucially, the TAS-20 correlates moderately with various fundamental emotional processes, personality traits, and clinical criteria, which are related but distinct constructs (see Lumley et al., 2007; Oogai & Fukunishi, 2003; Taylor & Bagby, 2012; Taylor et al., 2000). The TAS-20 captures aspects of emotional processing that are expected to be related to alexithymia.

Discriminant and Predictive Validity. The TAS-20 has enabled researchers to uncover associations between the core cognitive components captured by the scale and various psychological, medical, and psychiatric conditions (Leweke et al., 2012; Onur et al., 2013). For example, alexithymia is a valuable predictor of various clinical conditions associated with poor interoceptive awareness, including eating disorders, psychosomatic disorders, and substance-related and addictive disorders (Luminet et al., 2018; Sifneos, 1973). It is also a critical vulnerability factor for developing internalizing disorders like depression (Luminet et al., 2018, p. 152).

There are debates and discussions within the research community about how much alexithymia overlaps with other constructs, such as depression, anxiety, and certain personality traits. However, while there are apparent phenotypic and developmental similarities between alexithymia and certain psychopathologies, there is a general agreement in the literature that alexithymia is a distinct construct (see Taylor & Bagby, 2021). Relations between alexithymia and related but distinct constructs (e.g., depression) are complex and confounded by shared method variance (Güleç et al., 2013). The overreliance on self-report measures in alexithymia research may lead to overestimating correlations between alexithymia and other constructs due to shared method variance. This hypothesis is justified by an extensive meta-analysis conducted by Li and colleagues (2015). An analysis of 19 studies involving 20 study groups and 3572 participants reveals that the measurement method significantly moderates the association between depression and TAS-20 scores. These findings are consistent with other research by Luminet et al. (2018). As a potential source of bias, researchers must acknowledge and address this issue in their studies. By identifying and controlling for shared method variance, researchers can ensure that their results accurately reflect the true relations between constructs, leading to more reliable and valid findings in the field of alexithymia research.

Similarly, although alexithymia is strongly associated with other personality traits (e.g., neuroticism, openness to experience, and extraversion), it is not synonymous with any one factor (Luminet et al., 2018, p. 153). For example, the atypical interoception observed in individuals with elevated alexithymia can also be found in other partially overlapping constructs that entail emotional difficulties, such as neuroticism (Murphy et al., 2017). While studies confirm that individuals with high levels of both alexithymia and neuroticism share specific interoceptive deficits, such as those reported by Gaggero et al. (2022), these studies also corroborate the existence of other interoceptive deficits that are unique to alexithymia. These unique deficits result in lower interoceptive ability in individuals with high alexithymia (Gaggero et al., 2022). Overall, while there may be some overlap with other constructs, the current consensus within the research community supports alexithymia, as operationalized by the TAS-20, as a distinct and standalone construct.

Decision-Making Measurement and Operationalization

Decision-making is a multifaceted construct incorporating both ‘cold’ cognitive reasoning and ‘hot’ affective processing (Colautti et al., 2022; Mirabella, 2014). Deliberative or ‘cold’ decision-making entails rational calculations of the risks and benefits associated with various options. It requires an understanding of risk-to-benefit ratios, the capacity to recall relevant information, and working memory to compare and contrast different alternatives. On the other hand, 'hot' decision-making refers to the emotional and affective responses evoked by the available options.

***The Iowa-Gambling Task*.**

Relations between alexithymia and decision-making are most commonly explored using the Iowa Gambling Task (IGT; Bechara et al., 1994). The primary purpose of the IGT is to study how individuals make choices under conditions of uncertainty and to investigate the interplay between emotions, cognition, and decision-making. The IGT task simulates real-life decision-making scenarios and involves uncertainty about potential gains and losses. Participants are presented with four virtual card decks and instructed to select cards from them. Each card selection results in a gain or a loss of play money, and the decks differ in long-term outcomes. Two decks (C and D) are advantageous, providing smaller instant gains and losses, resulting in long-term positive consequences. On the other hand, the other two decks (A and B) are disadvantageous, offering high immediate gains and higher losses, leading to long-term negative consequences. Moreover, there are other differences between the four decks. Although both A and B decks are unfavourable, the choices of deck A are penalized in 50% of the trials, whereas deck B choices are penalized in 10% of the trials. Similar differences are evident with regard to decks C (50% losses) and D (10% losses). The instant losses for Deck D are larger than those for Deck C. The net score is calculated by adding the scores associated with card selections from advantageous decks (C + D) and disadvantageous decks (A + B). Choices are divided into equal blocks, and the calculation of the net score for each block assesses changes in decision-making over time. Typically, the net score (C + D) – (A + B) is used to analyze the results obtained from the IGT.

Participants are not explicitly informed about the advantageous and disadvantageous decks but learn through feedback provided after each card selection. Initially, individuals often prefer the advantageous decks due to the allure of immediate gains. However, as they gain experience and receive feedback, most individuals gradually shift their preference toward the advantageous decks, demonstrating a preference for advantageous long-term options. Thus, the IGT's decision-making quality is measured by assessing participants' ability to shift their card selections toward the advantageous decks (C and D) while avoiding the disadvantageous decks (A and B).

The developers of IGT understand the importance of physiological responses, particularly the anticipatory ones, when faced with risky options as critical indicators of decision-making processes (Bechara et al., 1994). During the trials, healthy individuals typically develop anticipatory physiological responses when approaching decks, A and B (i.e., the risky decks; Bechara et al., 1996; Damasio, 2005). These responses tend to precede observed risk avoidance and occur before participants consciously discern between the risky and advantageous decks (Bechara et al., 1997). In contrast, patients with damage to the ventromedial prefrontal cortex (vmPFC), a brain region that plays a crucial role in various cognitive and emotional processes, do not exhibit this anticipatory response (Schneider & Koenigs, 2017). Consequently, these patients often display distinct decision-making patterns in the IGT. They tend to choose significantly more cards from decks offering high immediate rewards, even when they fully comprehend the associated risks. This inclination towards riskier options frequently leads to adverse outcomes, such as bankruptcy.

The significance of these anticipatory physiological responses lies in their ability to provide insights into potential implicit and subconscious mechanisms involved in decision-making. These mechanisms are not accessible through conscious introspection alone. By occurring prior to conscious differentiation between risky and advantageous options, these responses suggest that our bodies possess an inherent capacity to detect and respond to potential risks before conscious awareness. These findings highlight the crucial role of emotion in adaptive decision-making and risk avoidance. Emotion-driven processes allow individuals to integrate affective information and make advantageous choices by balancing the assessment of risks and rewards. In real-life situations, variations in the experience of emotion among individuals may contribute to differences in evaluating different choice outcomes. Consequently, some individuals may be more inclined to make risky decisions. This has implications for various aspects of daily life, such as financial decisions, social interactions, and health-related choices, where assessing risks and rewards is paramount. Understanding and modulating these implicit emotional processes can help promote a more accurate assessment of choice outcomes and reduce excessive risk-taking.

The IGT and Alexithymia.

Studies examining the link between alexithymia and performance on the IGT have produced mixed results. Some studies have found that higher levels of alexithymia are associated with poorer decision-making on the IGT, in terms of making advantageous choices and avoiding risky options (Ferguson et al., 2009; Kano et al., 2011; Zhang et al., 2017). Other studies, however, have not replicated this association (Inman, 2007; Poletti et al., 2011). Furthermore, even among literature discussing the correlation between alexithymia and decision-making, there is notable diversity in observed associations across various dimensions. These include differences in performance on distinct trial types within the IGT, inconsistencies in interpreting study outcomes, difficulties in identifying group discrepancies, and fluctuations in overarching conclusions.

For example, Zhang et al. (2017) found noticeable differences in total IGT scores between individuals with and without alexithymia. Participants with high alexithymia tended to select fewer cards from the advantageous decks, particularly in the last trial of the task. Similarly, Kano et al. (2011) found that males with alexithymia were likelier to choose cards from the disadvantageous decks in later trials when compared to males without alexithymia but no group differences in total IGT scores were found between the two groups. At the same time differences in IGT performance related to alexithymia have been attributed to various factors, including ineffective evaluation of reward and loss stimuli (Kano et al., 2011), preference for instant reward (Zhang et al., 2017), reduced sensitivity to loss (Ferguson et al., 2009), and the inability to consolidate learning from earlier trials (Ferguson et al., 2009; Kano et al, 2011). This multifaceted array of findings underscores the intricate and nuanced nature of the interrelation between alexithymia and decision-making processes. Consequently, it becomes evident that a comprehensive understanding of this relationship necessitates a holistic consideration of the intricacies involved, and further investigations are warranted to disentangle the factors contributing to the variability observed, thereby fostering a more coherent and robust comprehension of the interplay between alexithymia and decision-making.

One key feature of the IGT is that participants are unaware of each deck's underlying probabilities and outcomes. Thus, through trial and error, they must learn which decks are advantageous and disadvantageous. Therefore, the choices made in the initial trials of the task are random, as participants have yet to experience the different win/loss contingencies of the decks. However, as they select cards, they receive feedback on monetary gains or losses, letting them gradually discern which decks are more favourable for long-term gains. Individuals must integrate this feedback and adjust their decision-making strategy to select cards from the advantageous decks to succeed in the IGT. This shift in behaviour demonstrates learning and adaptation and the interpretation of findings is consequently complicated due to the confounding nature of learning and decision-making processes in the IGT.

Analyzing participants' performance across different trial blocks can provide insights into their learning and decision-making progression (Buelow & Suhr, 2009). Observing an increase in advantageous choices and a corresponding decrease in disadvantageous choices over time indicates that participants effectively adapt their strategies based on feedback. Conversely, a persistent preference for disadvantageous decks or the failure to shift towards advantageous options in later trials may suggest challenges in learning. However, studies do not consistently show an association between alexithymia and preference for disadvantageous decks in later trials of the IGT. Nor do they consistently demonstrate overall group differences in net IGT scores between individuals with alexithymia and controls. Moreover, disentangling aspects of decision-making from learning in the context of the IGT poses difficulties due to the intertwined nature of participants' performance. Their results are influenced by their initial decision-making approaches as well as their capacity to learn and adjust them over time.

As such, the nuanced dynamics of participant performance underscore the complexity inherent in investigating the link between alexithymia and decision-making within the context of the Iowa Gambling Task. This necessitates cautious interpretation of findings and urges continued exploration to illuminate the underlying mechanisms governing the intricate relationship between alexithymia and decision-making. Indeed, although alexithymic individuals may face challenges in selecting advantageous cards in the IGT (Ferguson et al., 2009; Kano et al., 2011; Zhang et al., 2017), their decision-making processes could be influenced by several factors. Many of which could be directly or indirectly associated with their difficulties in emotional processing.

For example, alexithymia is associated with differences in the processing of risk, reward, and punishment (van der Velde et al., 2013; Saladin et al., 2012; Starita et al., 2016; Vermeulen et al., 2006). Alexithymic individuals may have a decreased sensitivity to punishment or a heightened sensitivity to reward, which can significantly influence their decision-making strategies. If individuals perceive rewards as greater than they are or undervalue potential risks, they may be less likely to make decisions that lead to advantageous outcomes. These variations may also hinder participants' ability to adjust expectations based on feedback from previous deck selections. This challenge in incorporating feedback may result in a continued inclination towards unfavourable choices or an inability to transition towards more favourable options, despite gaining experience in the task.

Difficulties in emotion regulation, common in individuals with high alexithymia (Venta et al., 2013), can further complicate decision-making processes. Emotions can play a significant role in decision-making, with positive emotions generally promoting risk-taking behaviour, while negative emotions may lead to risk avoidance. Therefore, if alexithymic individuals struggle to regulate their emotions effectively, their emotional state could disproportionately influence their decisions. This may lead to less rational and more impulsive choices in the IGT, regardless of their understanding of the task contingencies. Moreover, difficulties in emotion regulation may exacerbate the impact of abnormal risk and reward processing, leading to even more skewed decision-making in individuals with alexithymia. Given these complexities, it is crucial to utilize experimental paradigms to distinguish decision-making from learning and determine affective versus deliberative contexts. These paradigms play a vital role in understanding the cognitive and emotional processes that contribute to individual differences in decision-making.

The Columbia Card Task

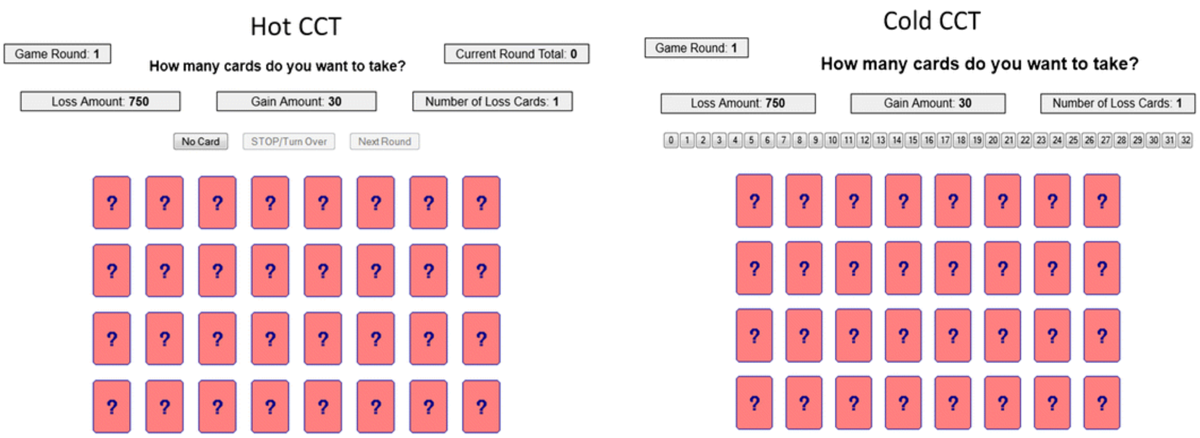
The CCT is a unique tool designed to examine how people make decisions when faced with uncertainty and risk. Developed by Figner et al. (2009), the CCT comes in two versions: the 'Cold' CCT and the 'Hot' CCT, each measuring different aspects of decision-making behaviour. At the start of each trial, 32 face-down cards are displayed on the screen in four rows of eight cards each, consisting of both gain and loss cards. Participants earn points by turning over gain cards and lose points by turning over loss cards. The point values and number of gain and loss cards in each trial are displayed at the top of the screen. The CCT's design varies three-game parameters: gain amounts, loss amounts, and the number of loss cards, to create eight trials, each presented three times, resulting in 24 trials per CCT version. The average number of cards turned over across trials measures a participant's risk-taking level.

In the Hot CCT (Figure 1), participants make stepwise incremental decisions about turning over a card and receive immediate feedback. One card at a time is selected by clicking on a specific card. The chosen card turns over, revealing whether it is a gain or loss card. If it is a gain card, a specific number of points (i.e., the gain amount) is directly added to the accumulated score per trial. The accumulated score is constantly visible and changes with every card turned over. Participants can decide whether they want to stop by pressing the STOP button presented at the top of the screen or whether they want to continue by turning over another card. If a loss card is turned over, a specific number of points (i.e., the loss amount) is subtracted from the accumulated score, and the trial is ended. Thus, the trial ends by pressing the STOP button or turning over a loss card. Once the trial ends, all cards are turned over, revealing which of the remaining cards were gain and loss cards. This 'hot' version of the task is designed to study the influence of emotional states on risky decision-making.

In the Cold CCT (Figure 1), a sequence of small buttons ranging from 0 to 32 is presented at the top of the screen. Participants indicate how many cards they want to turn around in a given trial by clicking one of these buttons at the beginning. No feedback is provided about their choice's outcome until the experiment's end. This task version is designed to measure decision-making under risk in a relatively 'cold,' cognitive, and deliberative manner.

Figure 1

Versions of the Columbia Card Task



Addressing Limitations of the IGT with the CCT. Individual differences analyses support the idea that the presence and directionality of associations between various factors (e.g., brain function) and risk-taking vary as a function of the risk-taking measures used to capture individual differences (Tisdall et al., 2020). It is worth noting though, that the CCT displays higher reliability and validity compared to other decision-making measures, such as the IGT (Frey et al., 2017). This consistency may be attributed to several factors. Firstly, unlike the IGT, the CCT explicitly provides participants with information on reward, loss, and probability contingencies. This allows participants to access complete information on the likelihood and value of different outcomes, creating a foundation for informed decision-making. The CCT yields objective and measurable outcomes, including the participant's preference for risky or safe options, the total amount of money won or lost, and their overall strategy in response to changes in these variables. This enables researchers to study how available reward, loss, and probability affect participants' decisions independently of their learning ability. The task structure of the CCT also more closely resembles real-world decision-making scenarios, such as choosing between risky options or evaluating potential gains and losses. Thus, the observed consistency indicates that the CCT assesses a trait-like feature of decision-making.

The CCT also exists in two versions, which reliably trigger affective versus deliberative processes to different degrees (Figner et al., 2009). In the Hot version, participants receive clear and immediate feedback about the outcomes of their card choices. In the Cold version, participants receive no feedback. This separation of affective and deliberative contexts allows for a more nuanced understanding of the influence of emotional experiences on decision-making, enabling researchers to disentangle affective and cognitive influences. Moreover, by comparing performance across the affective and deliberative conditions, researchers can examine whether participants with high alexithymia, for example, exhibit different patterns of decision-making in each context. This approach helps separate emotional experiences' influence from other related factors and provides a clearer understanding of the specific mechanisms underlying individual differences in decision-making.

Current Study

Aims

The primary aim of this study is to investigate the relationship between individual differences in the experience of emotion and decision-making across different affective contexts. We will utilize two well-established assessment tools to measure these constructs: the 20-Item Toronto Alexithymia Scale (TAS-20) and the Columbia Card Task (CCT).

Hypotheses

Persons scoring high in alexithymia demonstrate greater real-life risk-taking behaviours (Hahn et al., 2016; Panno et al., 2019; Manzoor et al., 2021) and are at heightened risk for developing psychopathology characterized by risky decision-making (Hamidi et al., 2010; Marchetti et al., 2019). Generally, individuals with clinically elevated alexithymia demonstrate greater risk-taking in laboratory decision-making tasks (Aite et al., 2014; Bibby & Ross, 2017; Ferguson et al., 2009; Kano et al., 2011; Manzoor et al., 2021; Scarpazza et al., 2017; Zhang et al., 2017). However, deriving conclusions from existing work is complicated as the studies use very different task paradigms, study designs, and samples. Therefore, committing to clear directional hypotheses when considering the CCT is challenging. Thus, the literature will be distilled into several partly competing hypotheses. Results will then be interpreted considering these hypotheses, and a judgement will be made to determine which set of hypotheses the results are most consistent. The CCT is a unique task, as it exists in two versions that differentially trigger deliberative versus affective decision-making processes (Figner et al., 2009). Past research on decision-making and alexithymia has employed decision-making tasks where it is less clear to what extent affective and deliberative decision-making processes are involved (e.g., the Iowa Gambling Task). Generally, alexithymia-related risk-taking on decision-making tasks is thought to occur due to distortions in the use of affective information during risk processing (Aite et al., 2014; Ferguson et al., 2009; Kano et al., 2011; Zhang et al., 2017). Thus, it is expected that a positive association between alexithymia and risk-taking will emerge, with this effect being more pronounced in the Hot version of the CCT when compared to the Cold version (Hypothesis 1A). Notably, alexithymia may also be associated with global deficits in executive functions, which underlies decision-making processes (Correro et al., 2021). In this case, the association between alexithymia and increased risk-taking is expected to be similar across both versions of the CCT (Hypothesis 1B).

The available literature provides no definite ideas about the underlying mechanisms responsible for these effects. As a result, models will consider the three-way interactions between CCT, alexithymia, and the three card game predictors: probability, gain, and loss. Examining the pattern of these effects will provide insight into the association between alexithymia and risk-taking. For instance, if alexithymia is linked to a higher tendency to take risks in the hot CCT and the effect of loss amount on risk-taking in the hot CCT is less significant for people with higher levels of alexithymia, then this could indicate that a reduced sensitivity to losses is contributing to the observed relationship between alexithymia and risk-taking in the Hot CCT.

Methods

Participants

The sample consisted of 192 students (72% female) aged between 16 and 28 years (*M* = 18.3, *SD* = 1.18). Participants were recruited from Western University's Research Participation Pool using SONA. All participants were fluent in English, with normal or corrected-to-normal vision. The sample included participants from diverse ethnic backgrounds, including African American, Caucasian, Asian, and Indigenous (Table 1). On SONA, interested candidates were informed about the study's general procedure and the inclusion and exclusion criteria; they were guaranteed privacy, anonymity, and confidentiality. If candidates wanted to participate, they used SONA to sign up for a time slot to enter the lab. They were then contacted through the SONA email system with confirmation and further study detail. Upon study completion, all participants were compensated through the SONA system with 2.0-course credits by their course-specific guidelines.

Table 1

Sample Background

Ethnicity	Count	% of total	Cumulative %
Not identified	8	4.2	4.2
Caucasian	71	37.0	41.1
Asian	104	54.2	95.3
African American	7	3.6	99.0
Indigenous	2	1.0	100

Note. *N* = 192

Procedure

Study participants arrived at a Western campus building at their designated time slot. They were guided to a testing room where they read a letter of information and consented to participate. After providing consent, they completed demographics and general mood questionnaires. Then, they undertook both versions of the Columbia Card Task, which were counterbalanced in order across participants. After each CCT version, participants responded to self-report questionnaire items related to their gameplay attitudes and strategies. Additional items were added to assess task-based emotional arousal after the final CCT version. Transdermal optical imaging was done using video recording participants' faces during the CCT. Between the different CCT versions, participants completed a block of questionnaires, and another block was administered after the final CCT version. Finally, participants were given a list of community resources for support and reminded that they could request a paper copy of the Letter of Information. SONA credit was granted within 48 business hours. The entire study protocol was computer-based and lasted for 2 hours.

Measures and Materials

The Columbia Card Task. The quantitative outcome variable of interest was ‘risk-taking,’ defined as the number of cards turned around (continuous, ranging from 0 to 32) in each game round. In the Hot CCT, game rounds end when the participant turns over a loss card. In these "censored" game rounds, it is impossible to know whether the participant would have turned over more cards if they had not encountered the loss card. In contrast, in the Cold CCT, the participant can always express how many cards they want to turn over without censoring.

In order to ensure that the statistical analyses accurately compare the hot and cold CCT, a model was utilized that considers the right-censoring in the hot CCT. This was achieved using the brms cens() function, which integrated the censored observations (see section 4.3 in Stan's User Guide for more; Stan Development Team, 2021). All game rounds in the cold CCT were treated as uncensored (the same approach of handling the censoring was used in Schaefer et al., 2022). Other predictor variables of interest included CCT version (Hot or Cold), probability (1 or 3 loss cards), gain amount (10 or 30 points), and loss amount (-250 or -750 points). These categorical predictors were coded using sum-to-zero contrasts.

The 20-Item Toronto Alexithymia Scale. Alexithymia was measured using the 20-Item Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994.a) This self-report scale comprises 20 items endorsed on a 5-point Likert-style scale (1 = strongly agree, 5 = strongly disagree). Total scores can range from 20 to 100, with higher scores indicating increased alexithymia. Total TAS-20 scores were standardized before being used in our models.

The Depression Anxiety Stress Scales. The Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995) is a 42-item self-report measure which captures negative emotional symptoms over the last week. Items are rated on a four-point Likert-type scale (1 = does not apply to me at all, 4 = Applies to me very much). The DASS is comprised of three subscales which are composed of 14 items each. The depression scale assesses anhedonia, dysphoria, hopelessness, self-deprecation, and lack of interest/involvement. There is some concern that variance in alexithymia may overlap with variance in depressive psychopathology (Luminet et al., 2018). Thus, a simple linear regression created a residualized alexithymia predictor, using DASS-21 total depression scores as the independent variable and total TAS-20 scores as the dependent variable. Models were run a second time, removing from the TAS-20 sum scores the portion of variance that the DASS-21 depression subscale score could linearly predict.

Analytic Strategy

All analyses described below were conducted using linear mixed-effects models in a Bayesian framework calculating credible intervals using the brm-function of the R-package brms (Bürkner, 2017), providing an interface to Stan (Carpenter et al., 2016). The default priors of the brms package were used. For visual inspection of the chains, density and trace plots of all parameters were created and evaluated (Bürkner, 2016). The CCT data was analyzed at the trial level without aggregation. Trial-by-trial card turning scores were analyzed as a function of CCT type, alexithymia, gain amount, loss amount, and the number of loss cards. Concretely, the primary model included predictors that represented the effects of alexithymia (between-subject), CCT type (Hot, Cold; within-subject), gain amount (10 points, 30 points; within-subject), loss amount (-250 points, -750 points; within-subject), and the number of loss cards (One card or three cards; within-subject). In addition, included was a two-way interaction between the CCT version and alexithymia. Furthermore, a three-way interaction between the CCT version, alexithymia and each card game predictor, probability, gain, and loss, were also included. Censoring was modelled as described above using a binary predictor 'censored' coding, whether a game round was censored or uncensored. To account for the data's repeated-measures nature and avoid inflated Type I errors, a maximum random effect structure was used in all models as recommended by Barr and colleagues (2013). The model included a random intercept per participant and random slopes for all within-subject main effects and within-subject interactions. All possible random correlations between random effects were also included. Using pseudo-syntax as used in lme4 (version 1.1.-15; Bates et al., 2015) and brms, the fixed and random effect structure would thus look like this: (number_cards_turned | cens(censored) ~ hot/cold * alexithymia * (prob + gain + loss) + (1 + hot/cold * (prob + gain + loss) | participant_code).

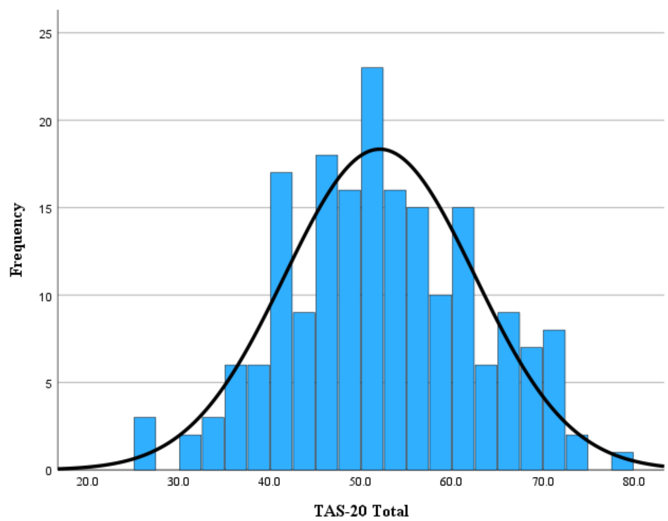
Results

Participants' scores on the TAS-20 ranged from 26 to 79 (*M* = 52.07, *SD* = 10.48) and were normally distributed (*skew* = 0.04, *kurtosis* = -0.38; Figure 2). The sample mean, and standard deviation were similar to those outlined in the TAS-20 testing norms for adult community populations (Parker et al., 2003). This suggests a representative sample of the typical range of alexithymia. Depression scores on the DASS-21 ranged from 0 to 33 (*M* = 13.32, *SD* = 9.08) and were significantly correlated with participants' TAS-20 scores, r (192) = .36, $p < .001$. Thus, a residualized alexithymia predictor was included within the models, removing from the TAS-20 sum scores the portion of variance that the DASS-21 depression subscale score could linearly predict.

All three task factors demonstrated credible intervals that did not encompass the value of 0 (see Table 2), indicating their substantial influence Participants selected more cards (a) when the probability of losing was low compared to high, (b) when the loss amount was low compared to high, and (c) when the gain amount was high compared to low. Participants were sensitive to changes in the gain amount, the loss amount, and the probability of losing and adjusted their level of risk-taking accordingly. Moreover, a distinct contrast emerged in card selection between the Hot and Cold CCT conditions, with participants consistently turning over more card in the Hot CCT condition. Interestingly, a notable interaction was identified between the CCT version and the loss amount. The shift from a small to a large loss amount resulted in a more pronounced reduction in the number of cards turned over by participants in the Cold CCT compared to the Hot CCT.

Figure 2

Histogram of Participants' Scores on the TAS-20



Regarding alexithymia, a notable 3-way interaction surfaced between alexithymia, CCT version, and loss amount (Table 2). Within the Hot condition, there was an observed positive correlation between TAS-20 scores and the number of cards turned over when the loss amount was high, whereas such a correlation was not evident when the loss amount was low. In contrast, the Cold condition displayed no significant interaction between alexithymia and loss amount.

Table 2

Results of the Primary Model With Number of Cards Turned Over per Game Round as the Dependent Variable

Predictor	B	Est. error	Lower 95%CI	Upper 95%CI	Sign.
Intercept	13.83	0.36	13.11	14.53	ns
Main effects					
CCT version (hot/cold)	-1.50	0.22	-1.92	-1.07	s
Probability of losing (3 or 1 loss card)	2.68	0.12	2.46	2.91	s
Gain amount (30 or 10 points)	0.72	0.10	0.51	0.92	s
Loss amount (-750 or -250 points)	1.02	0.11	0.81	1.24	s
TAS-20 total	0.38	0.34	-0.29	1.05	ns
2-way interactions					
CCT version × Probability of losing	0.12	0.09	-0.07	0.30	ns
CCT version × Gain amount	0.14	0.08	-0.02	0.30	ns
CCT version × Loss amount	0.30	0.07	0.16	0.44	s
CCT version × TAS-20 total	-0.12	0.21	-0.53	0.29	ns
TAS-20 total × Probability of losing	0.05	0.11	-0.17	0.27	ns
TAS-20 total × Gain amount	-0.13	0.10	-0.33	0.07	ns
TAS-20 total × Loss amount	-0.13	0.11	-0.34	0.08	ns
3-way interactions					
CCT version × TAS-20 total × Probability of losing	-0.00	0.09	-0.18	0.17	ns
CCT version × TAS-20 total × Gain amount	0.06	0.08	-0.10	0.21	ns
CCT version × TAS-20 total × Loss amount	0.16	0.07	0.03	0.29	s

Note. B = estimated regression coefficient; Est. error = estimated standard error; Lower 95%CI = lower boundary of the 95% posterior credible interval; Upper 95%CI = upper boundary of the 95% posterior credible interval; Sign = significance of the effect. If the 95% CI does not include 0, we interpret the effect as significant, with s = significant; ns = nonsignificant; CCT = Columbia Card Task.

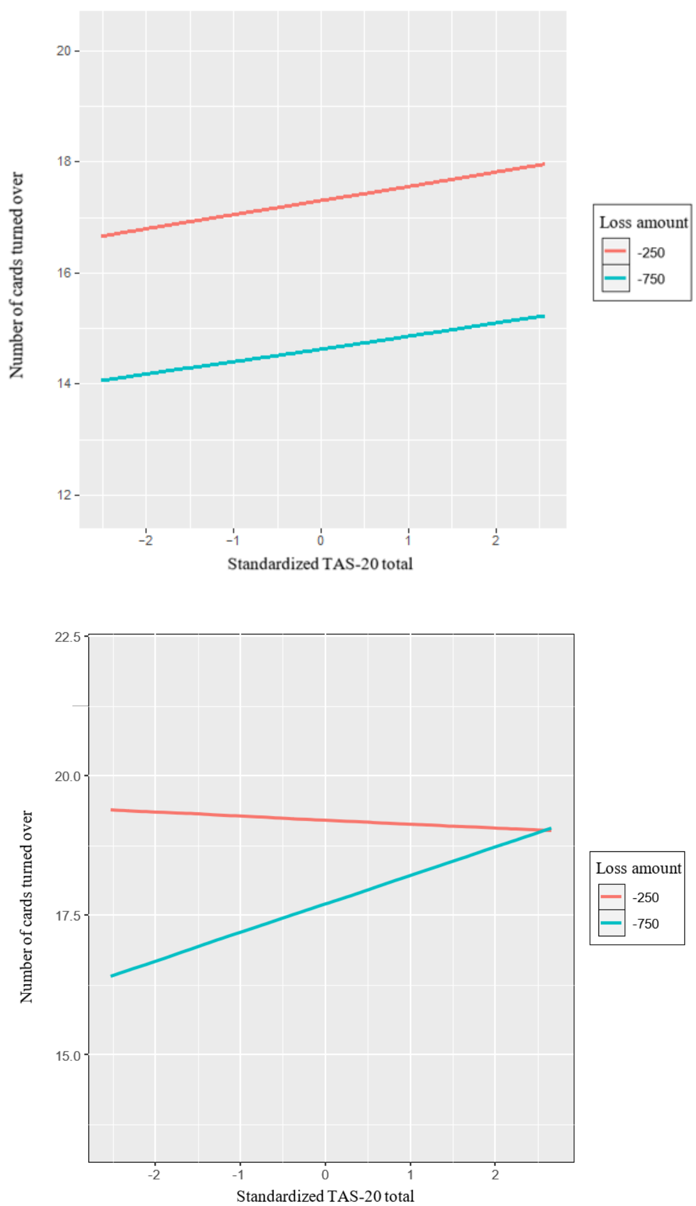
To elucidate the nature of this 3-way interaction, separate models were tailored to accommodate the data from the Hot and Cold CCT conditions, respectively. In the context of the Hot CCT condition, a 2-way interaction came to light between alexithymia and loss amount, with an estimated regression coefficient of B = -0.29 and a 95% credible interval of [-0.056, -0.02] (Figure 3B). Conversely, within the cold CCT condition, this interaction was absent, yielding an estimated regression coefficient of B = 0.01 and a 95% credible interval of [-0.22, -0.25] (Figure 3A).

Figure 3

Interactions Between Alexithymia and Loss Amount in the CCT

A

B



Note. 3A. In the Cold condition, alexithymia was unrelated to the number of choices both for large and small loss amounts. 3B. In the hot condition, alexithymia was positively associated with the number of card choices for large but not small loss amounts.

Table 3

Results of the Secondary Model Using Residualized TAS-20 Scores and the Number of Cards Turned Over per Game Round as the Dependent Variable

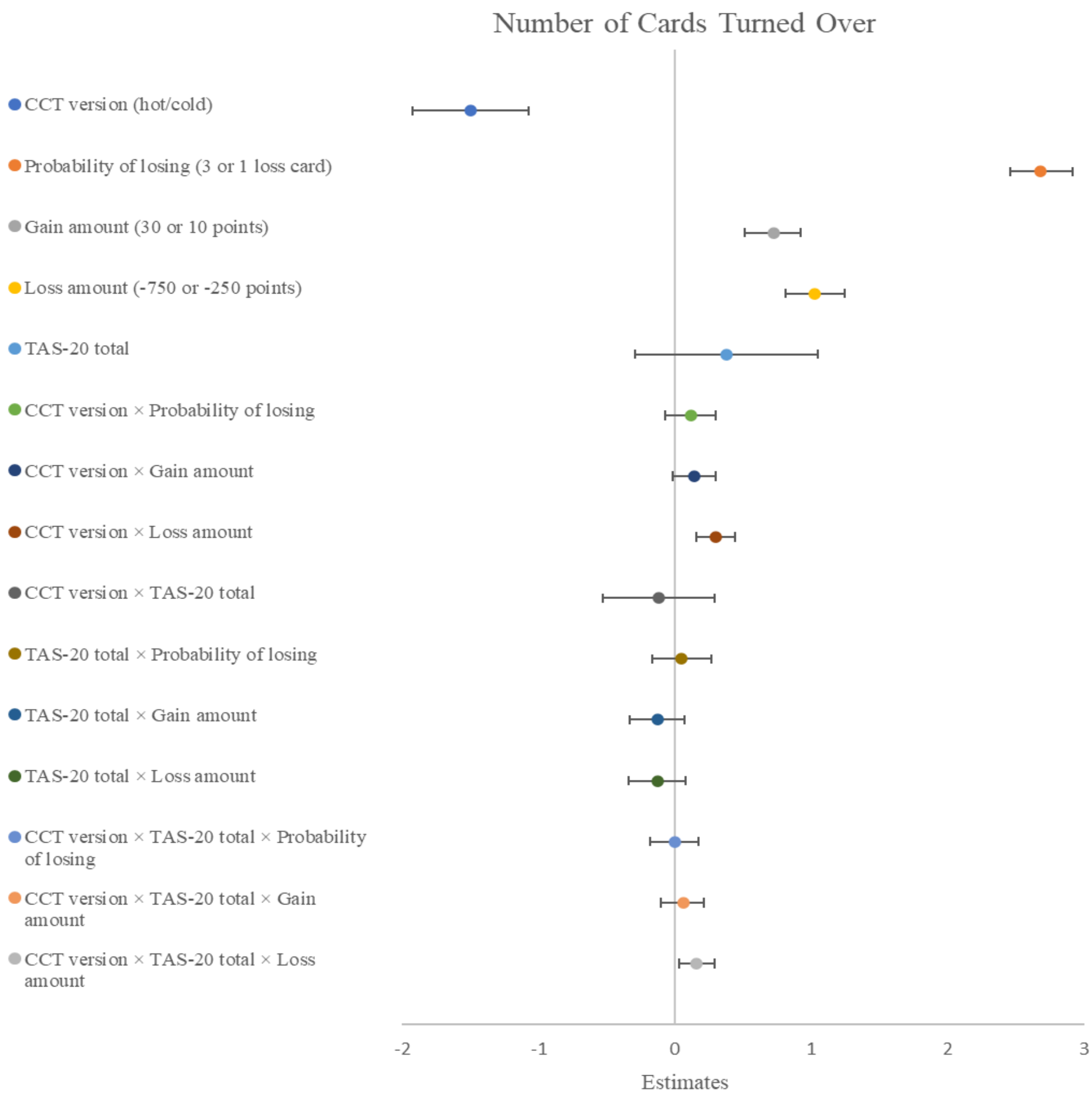
Predictor	B	Est. error	Lower 95%CI	Upper 95%CI	Sign.
Intercept	13.80	0.36	13.10	14.49	ns
Main effects					
CCT version (hot/cold)	-1.50	0.22	-1.93	-1.08	s
Probability of losing (3 or 1 loss card)	2.68	0.12	2.46	2.91	s
Gain amount (30 or 10 points)	0.72	0.10	0.51	0.92	s
Loss amount (-750 or -250 points)	1.03	0.11	0.81	1.24	s
Standardized TAS-20	0.47	0.32	-0.16	1.08	ns
Two-way interactions					
CCT version × Probability of losing	0.12	0.09	-0.07	0.30	ns
CCT version × Gain amount	0.15	0.08	-0.02	0.30	ns
CCT version × Loss amount	0.30	0.07	0.16	0.44	s
CCT version × Standardized TAS-20	-0.09	0.20	-0.49	0.31	ns
Standardized TAS-20 × Probability of losing	0.10	0.11	-0.11	0.32	ns
Standardized TAS-20 × Gain amount	-0.15	0.10	-0.35	0.05	ns
Standardized TAS-20 × Loss amount	-0.15	0.10	-0.36	0.04	ns
Three-way interactions					
CCT version × Standardized TAS-20 × Probability of losing	0.05	0.09	-0.13	0.23	ns
CCT version × Standardized TAS-20 × Gain amount	0.05	0.08	-0.11	0.20	ns
CCT version × Standardized TAS-20 × Loss amount	0.14	0.07	0.01	0.27	s

Note. B = estimated regression coefficient; Est. error = estimated standard error; Lower 95%CI = lower boundary of the 95% posterior credible interval; Upper 95%CI = upper boundary of the 95% posterior credible interval; Sign = significance of the effect. If the 95% CI does not include 0, we interpret the effect as significant, with s = significant; ns = nonsignificant; CCT = Columbia Card Task.

These findings persisted when utilizing depression residualized TAS-20 scores (Table 3). Notably, an intriguing observation arose upon visual inspection the credible intervals. Specifically, it became apparent that the precision of estimating the impact of alexithymia is comparatively lower than that of other effects (evident by wider 95% CIs for the alexithymia main effect compared to other effects, as seen in Figure 4). Remarkably, the 3-way interaction involving alexithymia, CCT version, and loss amount exhibited the highest precision among all the effects.

Figure 4

Regression Coefficients in the Main Model and Their 95% CIs



Note. The width of the 95% CIs can be seen as an indicator of the precision with which the effect was estimated. Effects, where the 95% CI includes 0 are considered "non-significant." We see that the effect at the very bottom (the 3way interaction CCT version x TAS-20 total x Loss amount) is significant, and the 95% CI was similarly narrow as some other effects (the main effect of TAS-20 total, though, has a much wider 95% CI, indicating less precision to estimate it).

Discussion

Summary of Findings

The current study investigated the relationship between alexithymia, a personality construct characterized by difficulties in identifying, processing, and expressing emotions, and decision-making under varying risk conditions. We examined levels of overt risk-taking and the underlying psychological processes (sensitivity to gains, losses, and probabilities) in two decision-making contexts - one that involved mainly deliberative processing, and another that involved both deliberative and emotional processing.

The results revealed effects of all three task factors on card selection, indicating that our participants were responsive to changes in gain amount, loss amount, and the probability of losing, and adjusted their risk-taking accordingly. This aligns with expected behavioral responses in risk-based decision-making tasks and validates the sensitivity of the CCT in assessing risk-taking behavior (Buelow, 2015; Figner et al., 2009; Weller et al., 2019). Moreover, the Hot CCT elicited a higher number of card selections compared to the Cold CCT. Additionally, participants appeared to be less sensitive to losses in the Hot CCT than in the Cold CCT. These findings support the notion that an affective state can influence attention to choice-relevant information (Pachur et al., 2014), highlighting the unique impact of the emotionally charged version of the task on decision-making behavior.

Regarding alexithymia, the three-way interaction among alexithymia, CCT version, and loss amount indicates a nuanced relationship between alexithymia and decision-making processes. Individuals with high alexithymia demonstrated reduced sensitivity to losses in the Hot CCT compared to their low alexithymia counterparts. However, this interaction was not observed in the Cold CCT, suggesting that alexithymia may be associated with a blunted response to potential losses specifically in emotionally charged decision-making contexts. Importantly, these findings remained consistent even after controlling for the influence of depression on TAS-20 scores, suggesting a specific role of emotional processing in modulating sensitivity to losses. The wider credible interval observed in estimating the main effect of alexithymia on risk-taking within our models may indicate the complex nature of the alexithymia construct and its interaction with various task and individual difference factors.

Comparison with Previous Research

Generally, alexithymia-related risk-taking is thought to occur due to distortions in the use of affective information during decision processing (Aite et al., 2014; Ferguson et al., 2009; Kano et al., 2011; Zhang et al., 2017). Indeed, heightened levels of alexithymia have been associated with selective deficits in performance on the IGT (Ferguson et al., 2009; Kano et al., 2011; Zhang et al., 2017). Various studies have explored the connection between alexithymia and decision-making in the IGT, but they have yielded conflicting results. Some propose that the association between alexithymia and a higher propensity for risk-taking in the IGT may be due to increased sensitivity to rewards (Grynberg et al., 2016; Zhang et al., 2017). In contrast, other researchers argue that the correlation between alexithymia and risk taking can be explained by a decreased aversion to loss, leading to a tendency to pursue losses in gambling situations (Bibby & Ferguson, 2011; Bibby & Ross, 2016).

Notably though, the IGT may not be well-suited to disentangle these conflicting findings. Indeed, the IGT presents a challenge when it comes to disentangling the role of reward and loss sensitivity in alexithymia-related risk-taking. The task involves variable magnitudes and frequencies of rewards and losses, and these two factors are inherently intertwined. When making decisions, it's important for participants to consider the magnitude of potential rewards and losses, as well as their likelihood of happening. This can make it challenging to distinguish between the impact of reward sensitivity and loss aversion on decision outcomes. Moreover, the IGT primarily serves as a learning task rather than a pure measure of information processing during decision-making. It requires participants to learn and adapt their decision-making strategies based on the feedback they receive from different decks of cards. This learning aspect of the task introduces cognitive processes that can confound the interpretation of results related to information processing more specifically.

One strength of the CCT is its ability to disentangle these distinct aspects of decision-making, enabling the identification of specific psychological processes (e.g., loss processing) that may be influenced by individual differences, such as alexithymia. Results from the present study show that people tend to take more risks when the potential benefits are greater and become more risk averse as the magnitude and likelihood of negative consequences increases. The outcomes of decisions are influenced by sensitivity to reward, loss, and loss probability. Alexithymia though, is negatively associated with risk sensitivity. Indeed, individuals with high levels of alexithymia are less sensitive to losses, but not to gains or outcome probabilities. It seems that those with higher levels of alexithymia do not take risks for the sake of bigger rewards, but rather have a reduced tendency to avoid risk. This suggests that increased selection of cards from risky decks among high alexithymia groups in the IGT may be attributed to a reduced sensitivity to losses, which does not elicit the same increase in loss avoidance observed in control and comparison groups.

The CCT, particularly its emotionally charged Hot version, is a suitable tool for studying the impact of affective personality traits like alexithymia on decision-making. Although other decision-making tasks like the IGT do involve emotions, they are less explicit and controllable than in the CCT. The discovery that alexithymia was only linked to a lack of sensitivity to potential losses in the CCT's Hot condition suggests that the connection between alexithymia and decision-making may be context dependent. This aligns with the definition of alexithymia, which captures individual differences in the experience of emotion. The blunted response to potential losses linked to alexithymia in the present study might partially explain the higher risk of addictive behaviors observed in individuals with high levels of alexithymia. Indeed, people with addictive behaviors tend to overlook the potential negative consequences of their actions, which is known as decreased loss aversion (Cabedo-Peris et al., 2022). This trait may be amplified in individuals with high levels of alexithymia, who not only underestimate potential losses due to decision-making biases but also have difficulty processing the emotional impact of these losses due to emotion regulation difficulties. This combination of factors may contribute to their increased vulnerability to addictive behaviors (Hamidi et al., 2010; Luminet et al., 2018, pp. 158-163; Marchetti et al., 2019; Palma-Álvarez et al., 2021; Thorberg et al., 2008; Thorberg et al., 2009; Thorberg et al., 2011).

Practical Implications

Findings from the current study hold potential implications in the field of health psychology. Previous research has demonstrated a connection between alexithymia and poor health behaviors, such as smoking, overeating, and lack of exercise (Lumley et al., 2007). One possible explanation for this association could be that individuals with high levels of alexithymia underestimate the negative health consequences of these behaviors due to their reduced sensitivity to losses, thereby exhibiting a greater propensity to engage in them. Thus, the observed blunted response to losses in emotionally charged contexts among individuals with high alexithymia may have far-reaching implications, influencing a wide range of behaviors and decision-making processes across various life domains.

When it comes to the treatment of disorders such as substance use or eating disorders, traditional therapeutic methods often focus on modifying negative behaviors and thought patterns, enhancing positive emotions, and reducing negativity associated with certain situations. However, our research suggests that an important factor may be overlooked: the role of sensitivity to potential losses in decision-making, particularly in emotionally charged contexts. Our findings indicate that individuals with high levels of alexithymia may not fully comprehend or emotionally respond to the potential negative consequences (losses) of their decisions. This lack of sensitivity to losses may contribute to maladaptive or risky behaviors, highlighting the need for therapeutic approaches that explicitly target this aspect of decision-making.

Interventions can incorporate techniques that enhance the perception and emotional impact of potential losses. Cognitive restructuring techniques can help individuals accurately perceive and evaluate potential losses. Experiential exercises, such as role-playing or exposure to virtual reality scenarios, can create a visceral experience of potential losses and their emotional impact. Mindfulness-based techniques can enhance attention and awareness of losses. In psychoeducation, emphasizing the significance of losses and their emotional implications in decision-making can help individuals with alexithymia understand why they may engage in risky behaviors and how they can change their decision-making patterns. Overall, incorporating techniques that enhance sensitivity to potential losses may be a crucial factor in successful therapeutic interventions for individuals with alexithymia.

Interestingly, enhancing sensitivity to potential losses also aligns well with Motivational Interviewing (Miller & Rollnick, 2012), a therapeutic approach commonly used in substance use disorders. One of its key strategies is developing discrepancy, which involves helping clients recognize the disparity between their current behaviors and their life goals and values, essentially highlighting the potential losses if they continue their current behaviors. In conclusion, the findings from our study suggest that traditional therapeutic approaches may benefit from supplementation with strategies that specifically target the increased sensitivity to potential losses in decision-making. This approach could potentially enhance the effectiveness of interventions for individuals with high levels of alexithymia and co-occurring disorders that involve maladaptive decision-making. Further research should aim to develop and test such interventions.

Limitations and Future Directions

Ecological Validity

The current study reveals an intricate relationship between alexithymia and decision-making processes, particularly under various risk conditions. However, this relationship may be oversimplified, hinting at an underpinning psychological complexity that has yet to be fully understood. Indeed, the wide credible interval observed for the main effect of alexithymia on risk-taking suggests that there may be other unaccounted factors in the present study, such as anxiety, impulsivity, and coping strategies, which might interact and modulate the relationship between alexithymia and risk-taking behaviors. For instance, those with high alexithymia and high anxiety might respond differently to potential losses than those with lower anxiety. Furthermore, individuals' coping strategies for managing negative emotions, which often accompany high-risk decisions, could interface with alexithymia, thereby shaping risk-taking behaviours. The cognitive component of alexithymia, characterized by difficulty identifying and describing feelings, could also interact with cognitive abilities like executive functions. A person with high alexithymia and strong executive functions may exhibit different patterns of risk-taking compared to someone with high alexithymia and weaker executive functions.

Despite the illuminating insights provided by laboratory tasks like the CCT, it is important to acknowledge their limitations. Laboratory settings inherently simplify the decision-making process and may not accurately reflect the complexity of real-world decision-making, which is influenced by a variety of psychological factors such as stress, fatigue, and social pressures. The affective intensity and personal relevance of potential losses in real-life situations may differ significantly from those in lab tasks, potentially leading to different decision-making patterns. Moreover, real-life decisions are embedded within a broader social context, where factors like peer influence, societal norms, and cultural values can significantly impact our decisions, but are often not accounted for in laboratory tasks. In the context of our study, social influences could further modulate the impact of alexithymia on sensitivity to losses in decision-making.

In conclusion, the ecological validity of laboratory tasks, which queries whether behaviors observed in these controlled environments can accurately mirror behaviors in natural, real-world settings, must be considered. Several studies suggest that performance on decision-making tasks doesn't always strongly correlate with real-life behavior (Dougherty et al., 2015; Frey et al., 2017). Therefore, while laboratory tasks provide valuable insights into the basic decision-making mechanisms, they might not fully encapsulate the complexity and richness of real-world decision-making. Consequently, the findings from this study should be interpreted with caution and validated in more ecologically valid settings.

Validity of Self-Reports

It is also important to note the use of self-report measures in assessing alexithymia. Although the TAS-20 is a widely used and validated instrument, self-reported measures are subject to biases, including social desirability. While using the TAS-20 to measure alexithymia has advantages in terms of ease of administration and direct access to individuals' subjective experiences, it is crucial to acknowledge the limitations of self-report measures in general. First, self-report measures are susceptible to social desirability bias, wherein individuals tend to answer questions in a manner that they perceive as socially desirable. Individuals with alexithymia, who may already struggle with understanding or expressing emotions, may have difficulties providing accurate insight into their emotional processing or may be hesitant to disclose aspects they perceive as unfavorable. Second, self-awareness is an issue. Alexithymia is characterized by difficulties in identifying and describing emotions, and individuals with high levels of alexithymia may lack sufficient insight into their emotional processing to report on it accurately. This raises questions about the validity of self-report measures in assessing a construct defined by limitations in self-awareness.

In light of these limitations, future research should consider adopting a multi-method approach to assessing alexithymia. For example, incorporating reports from close acquaintances or family members can provide additional perspectives on an individual's emotional functioning. Additionally, employing objective behavioral or physiological measures, such as facial expression recognition tasks or monitoring physiological responses to emotional stimuli, may offer more unbiased insights into the emotional processing characteristics of alexithymia. Moreover, structured clinical interviews specifically designed to assess alexithymia could be beneficial, as skilled clinicians may glean information about a patient's emotional functioning that the patient may not be aware of or disclose in a self-report questionnaire. In summary, while the TAS-20 is a useful tool for measuring alexithymia, relying solely on this self-report measure could introduce biases and limitations to our findings. Future studies would benefit from adopting a more comprehensive and multi-faceted approach to assessing alexithymia, in order to obtain a more accurate and nuanced understanding of this construct.

Measurement of Emotional Responding

A crucial avenue for exploration involves examining whether individuals with high levels of alexithymia demonstrate normal physiological arousal in response to potential losses but encounter challenges in leveraging this arousal to inform their decision-making. If this is indeed the case, it would support the idea that alexithymia involves difficulties in utilizing emotional information to guide cognitive processes, as opposed to an outright inability to experience emotion. This perspective frames alexithymia more as a dysfunction in emotional interpretation and application, rather than emotional generation. Contrarily, another possibility is that individuals with high alexithymia may not react affectively to potential losses at all, indicating a more profound deficit in emotion processing. This theory aligns with a description of alexithymia as an impairment in emotional reactivity. This perspective views alexithymia as a broader disruption in the emotional experience, encompassing not just the interpretation and application of emotions, but their very initiation.

To discern between these two possibilities, further research is crucial. Future studies should integrate physiological measures, such as skin conductance or heart rate variability, to decipher the affective responses to potential losses in individuals with high alexithymia. Such physiological markers can offer objective insights into the emotional activation and regulation processes, helping us better comprehend the underpinnings of decision-making in these individuals. Furthermore, longitudinal studies can help to trace the progression of these affective response patterns over time, providing a temporal dimension to our understanding. Additionally, they could examine the real-world implications of these responses. For example, do individuals with high alexithymia, who may show reduced affective responses to potential losses, exhibit riskier decision-making behaviors in the long term? Are they more prone to making decisions that result in significant losses in their personal or professional lives? Such studies can illuminate the practical significance and potential repercussions of alexithymia on decision-making. In summary, utilizing a multi-method approach that incorporates physiological measures and longitudinal investigations can deepen our understanding of alexithymia, shedding light on whether it reflects a difficulty in using emotional information for decision-making or a more fundamental deficit in emotional processing.

Multi-method approaches for measuring affective responding during decision-making are also necessary to better understand the relationship between alexithymia and reduced sensitivity to loss. For example, it would be worthwhile to investigate whether individuals with high levels of alexithymia exhibit normal physiological arousal in response to potential losses but struggle to utilize this arousal to guide their decision-making. This would be in line with the notion that alexithymia involves difficulties in using emotional information to guide thoughts and actions rather than an inability to experience emotion itself. Alternatively, individuals with high alexithymia may not respond affectively to potential losses at all, indicating a more fundamental deficit in emotion processing. This possibility aligns with the characterization of alexithymia as an impairment in emotional reactivity. Further research is needed to disentangle these possibilities. Future studies should incorporate physiological measures, such as skin conductance or heart rate variability, to understand the affective responses to potential losses in individuals with high alexithymia. Additionally, longitudinal studies could investigate how these patterns of affective responses to losses evolve over time and their relevance to real-world decision-making.

By employing a multi-method approach and investigating these research questions, we can deepen our understanding of alexithymia and its implications for emotional processing, decision-making, and real-world behavior. This holistic approach will contribute to the development of more effective interventions and strategies for individuals with alexithymia, ultimately improving their well-being and outcomes.

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Appendix

Letter of Information

Western SocialScience

Department of Psychology

Title of Research: **Emotion, Cognition, and Decision-Making in Alexithymia**

Principal Investigator:

Dr. J. Bruce Morton

Department of Psychology

Western University

Background

Emotion is an innate part of the human experience. The way we feel often has an impact on both the way we think and act. However, not all people have the same capacity for emotional experience. Indeed, alexithymia is a human trait which encompasses problems in emotional experiencing. High alexithymia is characterized by the inability to identify and describe emotions experienced by oneself. Alexithymia is often associated with a wide range of both psychological and physiological disorders. However, the relation between alexithymia and disorder is not well understood, especially in the context of decision making. Thus, the current study aims to better understand and explore the relations between alexithymia and different aspects of decision-making as they pertain to both lab-based tasks and real-life behaviours.

Introduction

In this consent document, "you" always refers to the study participant. Dr. J. Bruce Morton and his research team would like to invite you to participate in a study titled "Emotion, Cognition, and Decision-Making in Alexithymia". You are being asked to participate in this study because you are a university student at Western University. You must be fluent in English, have normal or corrected to normal vision. The study is completely voluntary and all information you provide will be kept confidential. If you agree to participate, we will ask you to come in for one lab session, during which time you will complete some computer tasks and questionnaires. During the computer tasks a video-recording device will be used to capture changes in your facial blood flow and facial affect. Video recording is a mandatory part of the study participation. The entire study will take you approximately **2 hours** and you will receive **2.0 SONA credits** as compensation.

Study procedure

The study will take place at the Western Interdisciplinary Research Building (WIRB). We will meet you in the lobby of the building approximately 10-minutes prior to the beginning of your scheduled session. The study will be completed using a computer in the lab. The study includes several questionnaires and tasks that might be repetitive and long. Please complete the tasks to the best of your ability. The study will take approximately 2 hours to complete. If at any time, you feel that you need a break just let us know and we will pause the testing.

Specifically, you will be asked to do the following:

1. <u>Questionnaires.</u> You will be asked to complete several self-report questionnaires that include a variety of questions about your mood, ability to recognize and describe your emotions, and history of risky and impulsive behaviour. The questionnaires will be administered intermittently across the lab session and will take approximately 45 minutes to complete.
2. <u>Columbia Card Tasks:</u> You will be asked to complete two versions of a dynamic computer card game that assesses risk-taking levels and information use strategies during decision-making. You will be asked to turn over cards with the objective of earning as many points as possible. After each version of the Card task, you will be asked to fill out a short self-report questionnaire about your game play decision making strategy. Each Card task will take approximately 30-minutes to complete.

   Video Recording: during the Columbia Card Task only, you will be videotaped using an iPhone. The iPhone will not be connected to the internet or any service provider. As you will be sitting down during these tasks only your face and upper body will be visible in the video. This video recording will be stored in a password protected file on the University's server and deleted from the iPhone immediately following transfer.. Recorded footage will be analyzed by an AI engine at the University of Toronto which calculates changes in blood flow using reflected red light from hemoglobin. For analysis at the University of Toronto, Digital data will be uploaded into a secure UWO share folder to protect participants' confidentiality. Secure file sharing allows files to be shared between different users or organizations within a protected mode that is secure from intruders and unauthorized users. This process is expected to take place immediately following the conclusion of the study. Raw data from these recordings (i.e., second-by-second calculations of blood pressure, heart rate, respiration, facial affect, and stress) will be retained indefinitely. No identifying information will be associated with these data.

Your total participation will be about 2 hours.

Voluntary participation

Your participation in this study is voluntary. You may decide not to be in this study, or to be in the study now and change your mind later. You may leave the study at any time without affecting your compensation. You do not waive any legal rights by signing the consent form to participate.

Withdrawal from the study

If you no longer want to participate in this research, or you do not want your data to be used in this research, you should tell either the experimenter that is with you in the room or contact Dr. J. Bruce Morton (see contact information at the first page). If the data has already been analyzed as part of a group, it will no longer be possible to withdraw those results. However, your data will not be used future analyses. You can request withdrawal of your data until seven years from data collection. After that time, it will not be possible to delete your data, as we will destroy all identifying information at that point.

Potential benefits of participation

While there are no immediate benefits to your participation, we hope that research from this study will help us better understand processes related to mood, understanding of emotion, and pathological decision-making.

Potential Risks of participation

Some of the questionnaire items ask about personal information and may be sensitive in nature. You reserve the right to skip any items you do not wish to answer, without penalty. Specifically, we will ask you to complete the Risky, Impulsive, & Self-destructive behavior Questionnaire (RISQ). The RISQ is a standard measure created by the Personality and Dysregulation Lab as the University of Delaware. This questionnaire asks several sensitive questions. More specifically, the RISQ asks about engagement in risky, impulsive, and self-destructive behaviors and if there were any consequences as a result of the behavior (yes/no). The RISQ also assesses your motivation (distress or pleasure) for engaging in the behavior. Filling out this questionnaire may make you feel uncomfortable or bring up traumatic memories. You have the right and the choice to not fill out the questionnaire, and you have the right and choice to skip questions if you do not want to answer them. At the end of the study, you will be provided a list of community resources you may access for support if needed. All information collected from these questionnaires and throughout the study will be associated with a unique ID code and not with your name or any other identifying information. Further, some of the computer tasks may be repetitive and boring. You may take a short break or terminate the task at any time.

Confidentiality

Your results will be kept confidential and will only be used for research purposes. All of the information you provide will be paired with a unique participant code which you will create at the beginning of the study. This code is necessary for (a) linking your questionnaire and Columbia Card Task data, and (b) removing your data from the dataset if requested in the future. Thus, you are encouraged to record your unique participant identifier in a safe place. No identifying information, such as your name or date of birth, will be collected in this study.

All questionnaire data will be collected and save on a secure online platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect all data. Western's Qualtrics server is located in Ireland. Data from this platform will be downloaded by the researchers and stored on secure, password- and firewall-protected servers at Western University. Performance data from the Columbia card task will only be stored on secure, password- and firewall-protected servers at Western University. Video-recordings of Columbia Card Task performance will be also be stored on secure, password- and firewall-protected servers at Western University. Video-footage will undergo automated analysis by an AI engine at the University of Toronto. Video access by this AI engine will take place via a secure file share to ensure your data remains confidential. Raw data from these recordings will be retained (i.e., second-by-second calculations of blood pressure, heart rate, respiration, facial affect, and stress) and video-footage will be immediately deleted following processing.

In line with current best practices in research, anonymous data from this study may be made indefinitely available to other researchers in the future; however, the data will contain no information that could be tracked back to individual participants. Open science initiatives allow for researchers from different universities to share their data upon completion of studies, in an effort to stimulate further use and exploration of existing data sets. De-identified data may be uploaded to an online forum in the form of a computer software file after the removal of any potentially identifying information.

Data from this study may be used in psychological publications or presentations. Possible identifying information will be removed before these data are used. Additionally, investigators may remove participant data from analyses if the data are incomplete, suggest low quality (e.g., inconsistent responding throughout procedures) or represent extreme outliers

Contacts for further information

Thank you for taking the time to read this consent form. If you have any further questions or comments concerning our study, please contact Dr. J. Bruce Morton.

If you have any questions about the conduct of this study or your rights as a research participant you may contact the Office of Research Ethics, The University of Western Ontario

Copies of this letter are available for your own records upon request

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Electronic Consent Form

(Participants will click “I Agree” or “I Do Not Agree” on the computer survey)

Title of Research: **Emotion, Cognition, and Decision-Making in Alexithymia**

Research Investigator:

Dr. J. Bruce Morton

Department of Psychology

Western University

I have read the Letter of Information and had all questions answered to my satisfaction. I understand the nature of the study and am aware that I can leave the study at any time. Clicking “I Agree” means that I consent to participate in this study.

- I Agree

- I Do Not Agree

Note: If participant clicks “I do not agree”, they will see the following message on the subsequent screen: “We thank you for your time spent taking this survey. Your response has been recorded”. The study will then be terminated”

Curriculum Vitae

Name:	Kaycee A. Stewart
Post-secondary Education and Degrees:	Trent University Peterborough, Ontario, Canada 2018-2021 B.Sc
Honours and Awards:	Thinking Globally, Acting Locally Graduate Student Award 2023 The Reva Gerstein Fellowship for Master's Study in Psychology Master's Fellowship 2022
Related Work Experience	Graduate Teaching Assistant The University of Western Ontario 2021-2023
Publications	Lowe, C. J., Mur, M., Bodell, L. P., Schmidt, K. Rizwan, L., Stewart, K. A., & Morton, B. J. (in review). Testing the causal role of left dorsolateral prefrontal cortex in modulating neurocognitive representations of food images: A registered report of a combined rTMS/fMRI study. Scientific Reports.