PONTIFÍCIA UNIVERSIDADE CATÓLICA DO RIO GRANDE DO SUL
FACULDADE DE PSICOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM PSICOLOGIA
MESTRADO EM PSICOLOGIA

TRANSLATION AND ADAPTATION OF COLUMBIA CARD TASK AND AFFECTIVE AND DELIBERATIVE ASPECTS OF DECISION-MAKING DURING DEVELOPMENT AND CRACK USE

BRUNO KLUWE SCHIAVON

Dissertação apresentada ao Programa de Pós-Graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul como requisito parcial para a obtenção do grau de Mestre em Psicologia.

Porto Alegre
Janeiro, 2015

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Dissertação de Mestrado realizada no Programa de Pós-Graduação em Psicologia da Pontifícia Universidade Católica do Rio Grande do Sul, como parte dos requisitos para a obtenção do título de Mestre em Psicologia. Área de Concentração em Cognição Humana

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RESUMO

Tomar decisões adaptativas requer ponderação dos riscos e benefícios, e a capacidade de aprender de acordo com as mudanças do ambiente. Além disso, as escolhas do dia-a-dia podem ser influenciadas por fatores contextuais (por exemplo, exposição ao feedback) e fatores individuais (por exemplo, estágios de desenvolvimento e psicopatologias). Particularmente, duas condições específicas referentes aos estágios de desenvolvimento e psicopatologias têm sido amplamente relacionadas a alterações no processo de tomada de decisão e, consequentemente, aumento de comportamentos de risco: adolescência e dependência química. A dependência de cocaína tem sido relacionada déficits na tomada de decisão, uma vez que o uso contínuo e impulsivo da droga está relacionado com a diminuição do controle inibitório e aumento da sensibilização a recompensa, levando ao uso compulsivo da droga. Modelo de duplo-processamento sugerem que esse desequilíbrio leva a um aumento dos comportamentos de risco. A adolescência é um período de desenvolvimento marcado pelos comportamentos de risco, no qual as diferentes trajetórias de desenvolvimento e maturação de regiões do cérebro envolvidas em processos de motivação/recompensa e controle inibitório pode levar ao aumento desses comportamentos. Embora esforços estejam sendo feitos para elucidar como a desregulação entre o controle cognitivo e os sistemas de recompensa podem explicar os comportamentos de risco na adolescência e na dependência química, os mesmos têm sido realizados separadamente. **Objetivos**. A presente dissertação teve como objetivo investigar a relação de fatores contextuais (ou seja, contextos que instigam processos afetivos e contextos que instigam processos deliberativos) e os fatores individuais (dependência de cocaína e adolescência), no processo de tomada de decisão (ou seja, comportamentos de risco e uso de informações). Para atingir este objetivo, a dissertação é composta por dois estudos. O primeiro, com o objetivo de adaptar o Columbia Card Task (CCT) para Português do Brasil, seguindo as diretrizes nacionais e internacionais para tradução, e realizando um estudo piloto com 29 estudantes universitários. O segundo estudo teve como objetivo comparar o papel do feedback e do uso de informação explícita nos comportamentos de risco (processos afetivos) e uso da informação (processos deliberativos) em 27 usuárias de crack, 18 adolescentes do sexo feminino e um grupo

controle composto por 20 mulheres adultas. **Resultados**. O primeiro estudo mostrou que o CCT foi devidamente adaptado para o Português do Brasil. O estudo piloto sugere que a manipulação do feedback entre as condições do CCT teve um efeito sobre os comportamentos de risco e uso das informações. O segundo estudo mostrou que as usuárias de crack não apresentam uso de informação em nenhuma das condições do CCT, apesar de que, durante a condição com feedback, o grupo de usuárias de crack não diferiu do grupo de adolescentes e adultos controles. Adolescentes usam a informação "probabilidade" para tomar decisões; contudo, adolescentes tomam escolhas mais arriscadas no CCT quando comparadas ao grupo controle, independente da exposição ao feedback. **Conclusões**. Nossos resultados sugerem que a versão Brasileira do CCT é um método versátil para a avaliação do processo de tomada de decisão afetiva e deliberativa sob risco, de acordo com diferentes cenários de manipulação de feedback. Além disso, o feedback tem um papel diferente na tomada de decisão dos usuários de crack do sexo feminino e adolescentes do sexo feminino.

Palavras-Chaves: Cognição, Tomada de Decisão, Comportamento de Risco, Julgamento, Desenvolvimento, Adição;

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ABSTRACT

Making adaptive decisions requires weighing risks and benefits and the ability to learn about an ever-changing environment. Ordinary choices ca be influenced by contextual factors (e.g., feedback exposure, affective- or deliberative-based scenarios) and individual factors (e.g., developmental stages and psychopathologies). Particularly, two specific conditions regarding developmental stages and psychopathologies have been extensively related to alterations in decision-making processes and consequently increased risk-taking behaviors: adolescence and drug addiction. Cocaine dependence has been related with poor decision-making, since continuous drug abuse shifts from controlled drug use (decreasing deliberative inhibitory control) to compulsive drug use (increasing the reward sensitization)—the dual-processing perspective—which opens a vulnerability window for risk-taking behaviors. Adolescence is a natural developmental period marked by risk-taking behavior, in which different developmental trajectories of brain regions involved in reward motivation and control processes may lead to adolescents' increased risk-taking. Although efforts have been made to elucidate how the dysregulation of cognitive control and of the reward-affective system leads to risk behavior in drug addiction and adolescents, it has been mostly performed separately. **Objectives**. The present dissertation aimed to (1) adapt the Columbia Card Task (CCT) to Brazilian Portuguese and (2) investigate the relation of contextual factors (affective- and deliberative-based contexts) and individual factors (drug addiction and adolescence) in decision-making processes (i.e., risk-taking behavior and information use). To achieve this goal, this dissertation is composed of two studies. **Methods**: To translate and adapt the CCT we followed standardized guidelines and performed a pilot study with 29 university students. In the second study, we compare the role of feedback and the use of explicit information in risk-taking (affective process) and information use (deliberative process) in 27 female crack cocaine users (CU) and 18 female adolescents (AD) in comparison to 20 female adult controls (CG). **Results**. The first study showed that CCT was adequately adapted to Brazilian Portuguese. The pilot study suggests that manipulation of feedback among CCT conditions had an effect on the risk-taking index and information use. The second study showed that CU showed a lack of information use on both CCT conditions, despite the fact that during the

delayed-feedback condition, CU did not differ from CG on risk-taking behavior. Adolescents mostly used the “probability” information; notwithstanding, they did not modulate their responses, making riskier choices in both delayed- and no-feedback conditions when compared to CG. **Conclusions**. Together, our results suggest that the Brazilian version of CCT performs well and is a versatile method for the assessment of affective and deliberative decision-making under risk according to different feedback manipulation scenarios. Moreover, the feedback plays a different role in the decision-making of female crack cocaine users and female adolescents.

Keywords: Cognition, Decision-Making, Risk Behavior, Judgment, Development, Addiction;

SUMMARY

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1. INTRODUCTION

1.1 A Theoretical Framework of Decision-Making

Decision-making has been defined as a dynamic cognitive-emotional process. The idea of process came from the fact that decision-making cannot be thought of as an isolated action (Ernst & Paulus, 2005) and requires, at least, five basic steps: the representation of feasible actions (integrating internal and external states), the evaluation of the reward probabilities and risks associated with each possible action, the selection of the chosen action, the evaluation of the outcomes, and the capacity to learn and update representations and values to next decisions (Rangel, Camerer, & Montague, 2008).

In turn, the dynamic characteristic of decision-making occurs because each day individuals make choices that could vary according to contextual and individual factors (Figner et al., 2010). Concerning contextual factors, decision-makers could be influenced by situational aspects, which means that during ethical dilemmas someone could show conservative behaviors, while during financial dilemmas the same person could show risky behaviors. Some contexts also provide explicit knowledge of exact risks and benefits involved—as a casino roulette game—while other contexts require that risks should be estimated from prior knowledge—such as investing in the stock market or even taking an umbrella on a cloudy day (e.g., risky or uncertainty scenario). In addition, the ratio of the time it will take to achieve the expected profits and the possible consequences of the action play a crucial role in choices and might be considered when someone asks for a loan, uses cocaine, or has unsafe sex (e.g., immediate discounting/feedback, delayed discounting/feedback).

Most of the time, these contextual variables could be associated with individual differences that also affect our choices. For example, cognitive abilities such as executive functioning, intelligence, memory, and attention might be related to successful application of decision rules (Li, Baldassi, Johnson, & Weber, 2013; Masuda, Locke, & Williams, 2015; Missier, Mantyla, & Bruin, 2010). In the same way, individual differences regarding impulsivity and sensation-

seeking can modify decision-making behaviors, varying the sensitivity to gains and losses (Mukherjee, 2011; Penolazzi, Gremigni, & Russo, 2012). Personal experiences, such as early life stress, has been related to unusual decision-making (Nakao et al., 2013). Developmental stages (e.g., childhood, adolescence, adulthood, old age), are marked by different patterns of risk-taking or risk-avoidance behaviors, with the assumption that evaluation of gains-losses vary across the lifespan (Mohr, Li, & Heekeren, 2010). In addition, several clinical studies have suggested that stress, mood, and anxiety could affect decision-making. For example, acute stress is associated with euphoria and reward-like properties that may promote risk-taking behavior (van den Bos, Harteveld, & Stoop, 2009). In the same way, individuals with anxiety disorders show an increased bias toward threat-related content and an intolerance of uncertainty, while those with depression show reduced responsiveness to reward (for a review, see Paulus & Yu, 2012). Particularly, two specific conditions regarding developmental stages and psychopathologies have been extensively related to alterations in decision-making processes and consequently increased risk-taking behaviors: adolescence and drug addiction.

1.2 Decision-Making and Adolescence

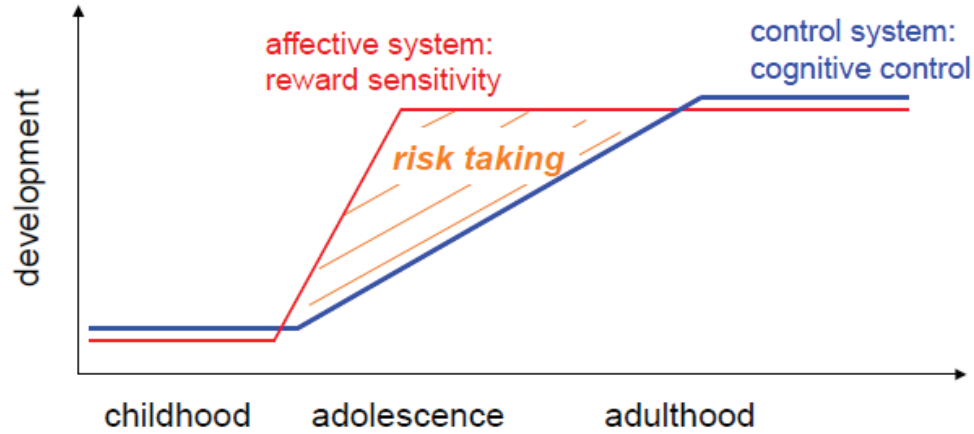
Adolescence is a developmental period between 10 and 19 years of age (WHO, 2013), marked by several biological, psychological, and behavioral alterations. According to an adaptive perspective, these changes lead to reproductive maturity and increases in exploratory tendencies (Crone & Dahl, 2012; Riddell & Pepler, 2014). For these reasons, adolescence is also characterized as a natural and expected known period of heightened risky behaviors, impulsivity, and emotional volatility, which tends to decline linearly from young adulthood (Figner, Mackinlay, Wilkening, & Weber, 2009).

Cognitive/behavior findings have suggested that there is a decrease in delaying reward discounting paradigms between 16 and 20 years old, indicating a decline in the propensity to make impulsive choices from adolescence to young adulthood (Anokhin, Golosheykin, & Mulligan, 2014). Moreover, teenagers who performed worse on executive functioning tasks showed more risk-taking behaviors during risk scenarios and explicit information use (Schiebener, García-

Arias, García-Villamisar, Cabanyes-Truffino, & Brand, 2014). Interestingly, alterations in decision-making seem to be more prominent when adolescents face affective-based contexts, for example, social approval from peers (Jose Rodrigo, Padron, de Vega, & Ferstl, 2014). For instance, risky activities such as use of alcohol and other substances are strongly influenced by perceived peer engagement and sensation-seeking (Steinberg, 2008).

To explain such findings, a developmental hypothesis of multiple neural systems involved in information processing has discussed that differential developmental trajectories of brain regions involved in motivation and control processes may lead to adolescents' increased risk-taking in general (Ernst & Korelitz, 2009; Steinberg, 2005) (see **Figure 1**). The so-called developmental dual-processing models of decision-making highlight the faster maturation of subcortical affective brain areas related to reward processing in comparison to more slowly maturing frontal cortical brain areas related to cognitive control (Figner et al., 2009). This gap could open a vulnerability window to adolescents to make decisions that are more emotional, less rational, overvaluing immediate gains, and not sufficiently weighing long-term outcomes.

Figure 1.
Adolescent risk-taking on expected development according with dual-processing models.



Note. Retrieved from: Figner, B (2009) Affective and Deliberative Processes in Risky Choice in Children, Adolescent and Adulthood;

According to this perspective, adolescents and adults might differ in their deliberative-controlled processing, especially when they face high affective involvement. However, without affective involvement, the dual-processing perspective assumes that adolescents and adults might differ less in their

deliberative-controlled processing (Figner et al., 2009). This hypothesis is supported by neuroimaging studies, which indicate that during risk scenarios, adolescents employed more neural resources than young adults did in the right dorsolateral prefrontal cortex (i.e., related to the controlled system), denoting the necessity to allocate more cognitive engagement to evaluate risks (Jose Rodrigo et al., 2014). However, some studies discuss that this activation during risk-taking simulations is more diffuse when compared to the activation of areas related to reward sensitivity (e.g., ventral striatum and nucleus accumbens), which are more focused and stronger (Sercombe, 2014).

Furthermore, the delayed maturation of cortical areas associated to cognitive/behavioral inhibition are related with impulsivity, which might explain why the likelihood of initiating addictive behaviors is higher during adolescence than during any other developmental period (Paulsen, Platt, Huettel, & Brannon, 2012). Besides that, adolescents are more likely to enter an addiction trajectory after their initial exposure to drugs, instigating some authors to draw a parallel between risk behavior patterns in adolescence and drug addiction (Gladwin, Figner, Crone, & Wiers, 2011).

1.3 Decision-Making and Substance Use Disorder

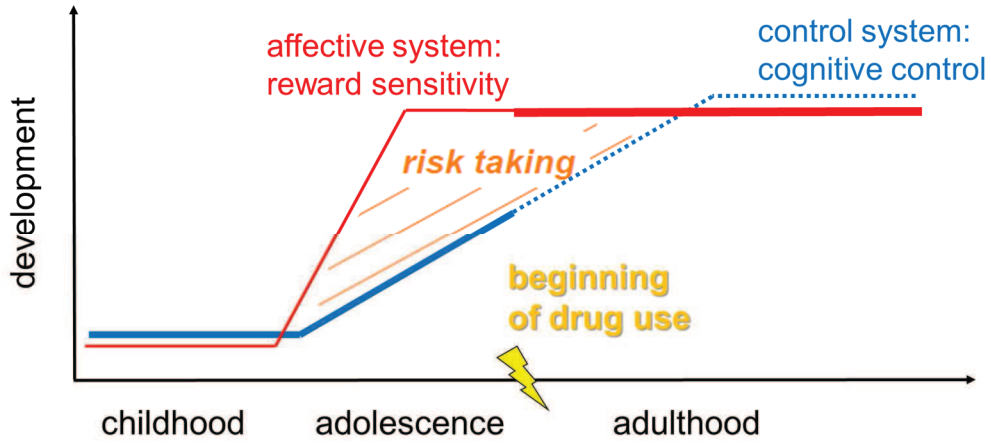
Substance use is a risk behavior. Even when it does not lead to addiction, it exposes individuals to accidents, suicide, and violence (Degenhardt & Hall, 2012), alters cognitive and motor functions (Spronk, van Wel, Ramaekers, & Verkes, 2013), and increases unsafe sexual behaviors associated with a variety of infections such as HIV and hepatitis (Johnson & Bruner, 2013). When it leads to addiction, it is related to innumerous chronic comorbidities such as heart disease, pulmonary disease, and psychiatric disease (Darke, Kaye, McKetin, & Duflou, 2008), a decrease in social relationships, engagement in education, entering the workforce, and it is also associated with premature death, morbidity, and general disability (Degenhardt & Hall, 2012). Hence, not only the beginning but also the maintenance of drug-seeking risky behaviors is related to poor judgment and a series of maladaptive choices (Lucantonio, Stalnaker, Shaham, Niv, & Schoenbaum, 2012b; Volkow & Baler, 2014). These particularities encouraged the researchers to think that addictions are brain disorders that not

only affect reward neural pathways, but also neurobiological mechanisms involved in decision-making (Cadet, Bisagno, & Milroy, 2014).

Behavioral and cognitive findings have shown that drug addiction influences decision-making processes. For example, cocaine users have been associated with a decrease delaying rewards and problems in learning to choose disadvantageously (Cunha, Bechara, de Andrade, & Nicastri, 2011; Spronk et al., 2013; Verdejo-García, Vilar-López, Pérez-García, Podell, & Goldberg, 2006). Similarly as with adolescence, the effects of affective-based contexts seem to be more pronounced in decision-making processes in drug addiction. For example, concerning social decisions, even recreational cocaine users show selfish choices (Hulka et al., 2014), which corroborates previous findings indicating that early age onset of cocaine use was associated with more prominent empathy impairment (Preller et al., 2014). In the same way, some of the major reasons for the high rates of relapse in cocaine addiction are related to increased stressful responses such as craving and psychosocial stress, suggesting that high levels of emotional engagment could affect deliberative inhibitory control (Back et al., 2010).

In this regard, the cognitive psychopathology discussion about addictive behaviors has also corroborated the dual-processing idea that decision-making processes are related to an imbalance between two competing neural systems, an affective-based one and a deliberative one (**Figure 2**) (Stevens et al., 2014; Volkow & Baler, 2014). These findings were also supported by neuroimaging studies that described impairments in decision-making associated with prefrontal dysfunctions and alterations during both acute and prolonged drug exposure.

Figure 2.
Risk-taking effects on drug addiction according with dual-processing models.



Note. Adapted from: Figner, B (2009) Affective and Deliberative Processes in Risky Choice in Children, Adolescent and Adulthood;

One of the acute changes derived from drug abuse is related to the increase in dopamine in the reward network (e.g., nucleus accumbens), which might be related to the later conditioned cue-elicited craving (Baler & Volkow, 2006). However, the chronic exposure to drug abuse can trigger a variety of epigenetic, molecular, and circuitry changes that facilitate the transition from casual to compulsive drug use (for a review, see Volkow & Baler, 2014). In this sense, preclinical findings support that cocaine-seeking behaviors are associated with dysregulation of the reward-network dopamine system, which includes the ventral tegmental area, medial and orbital prefrontal cortex, nucleus accumbens, and amygdala (Lucantonio, Stalnaker, Shaham, Niv, & Schoenbaum, 2012a). Therefore, while initial experimentation with drugs could be related to impulsivity behavior, continued drug use is related to the gradually impairment of cognitive control functions and the increase in the dysregulation of reward sensitivity (Gladwin et al., 2011). Moreover, later phases of addiction were associated with negative reinforcement that may trigger craving sensations (Volkow & Baler, 2014).

Although adolescence and drug addiction are marked by distinct biological and psychological changes, the cognitive theoretical framework that underlies the explanation of risk-taking behavior is also based on dual-processing models of reasoning, which instigate further behavioral comparisons. Therefore, to conduct such comparisons, it is necessary to use a decision-making task capable of

assessing both risk-taking and evaluation of gains, losses, and risks during affective- and deliberative-based contexts.

1.4 The Columbia Card Task (CCT)

CCT is an experimental computer card game developed by Figner and Voelki (2004) based on dual-processing models to assess deliberative and affective aspects of decision-making (Figner & Voelki, 2004). The task was composed of three conditions that vary according to the feedback displayed and the number of possible choices per round. The author named these conditions as cold (no-feedback and a unitary choice per round), warm (delayed-feedback and dynamic multiple choices per round), and hot (immediate-feedback and dynamic multiple choices per round).

Figner (2009) highlighted that CCT has two main differences from other dynamic and non-dynamic risk-taking tasks. First, despite assessing risk-taking, CCT also assesses the complexity of the decision maker's information use (Figner et al., 2009). Therefore, it is possible to determine which of the three factors (number of loss cards, value of loss cards, and value of gain cards) should affect risk-taking behavior both at the individual and group levels. The second difference of CCT from others tasks is related to the three mentioned conditions that comprise it, which allow us to investigate the influence of feedback on decision-making (Figner et al., 2009; Holper & Murphy, 2013; Pripfl, Neumann, Köhler, et al., 2013). According to the original authors, the feedback triggered emotional responses that, according to the dual-processing models, might lead to riskier behaviors and less information use (Figner et al., 2009).

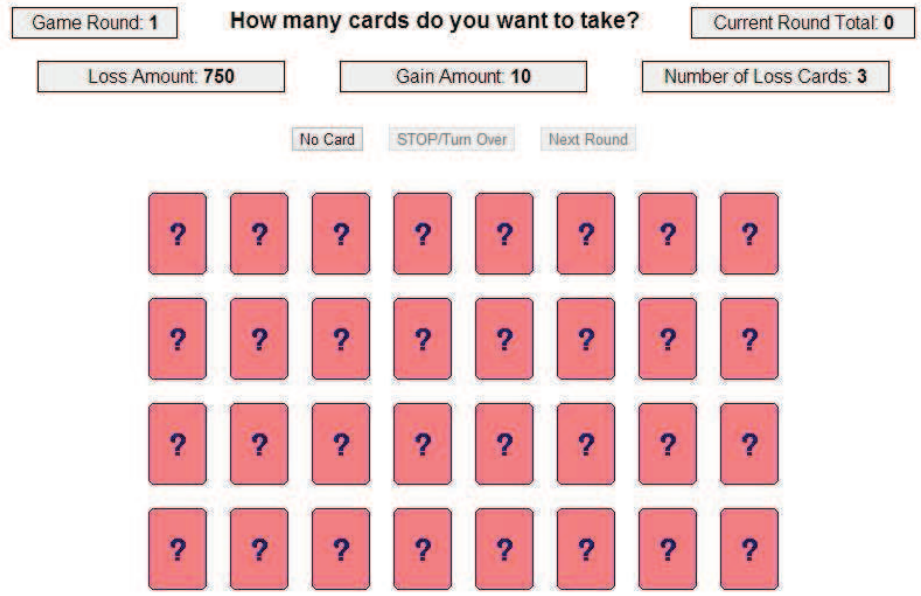
1.4.1 CCT development

The first version of CCT had only one condition (immediate-feedback, hot condition) and was composed of 63 rounds. Participants were exposed to 32 facedown cards, displayed in four rows of eight cards each, and had access to three main information: a) number of hidden loss cards (varying between 1, 2, and 3); b) amount of gain per winning card (varying between 10, 20, and 30); and c) amount of loss (varying between 250, 500, and 750). This information changed

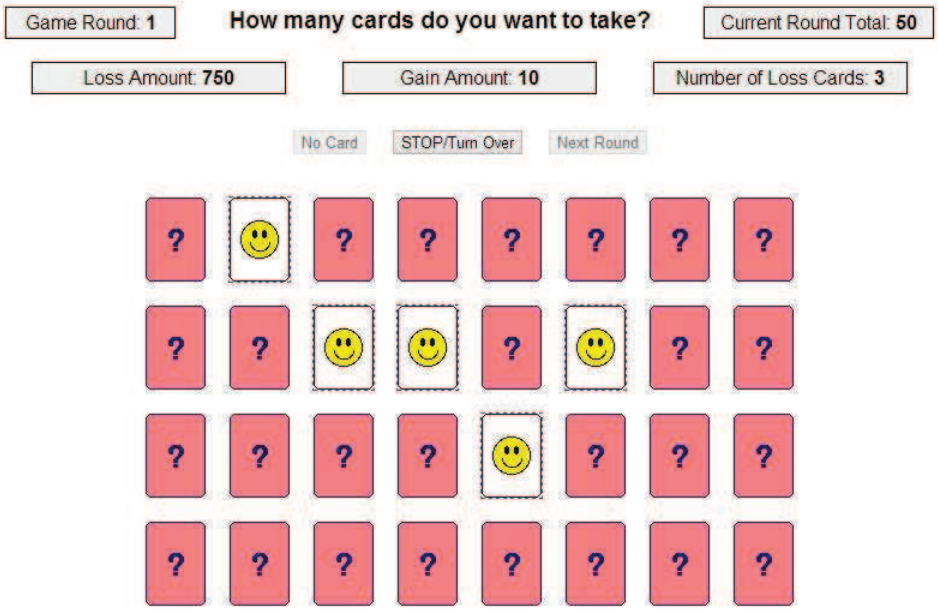
with every round of the game, according to the factorial design of the game (Figner & Voelki, 2004). Participants also knew the number of the current game's round and their current score, which changed as each new card was chosen (Figner & Voelki, 2004) (**Figure 3**).

Figure 3.
CCT Immediate-feedback 'Hot' condition

a)



b)



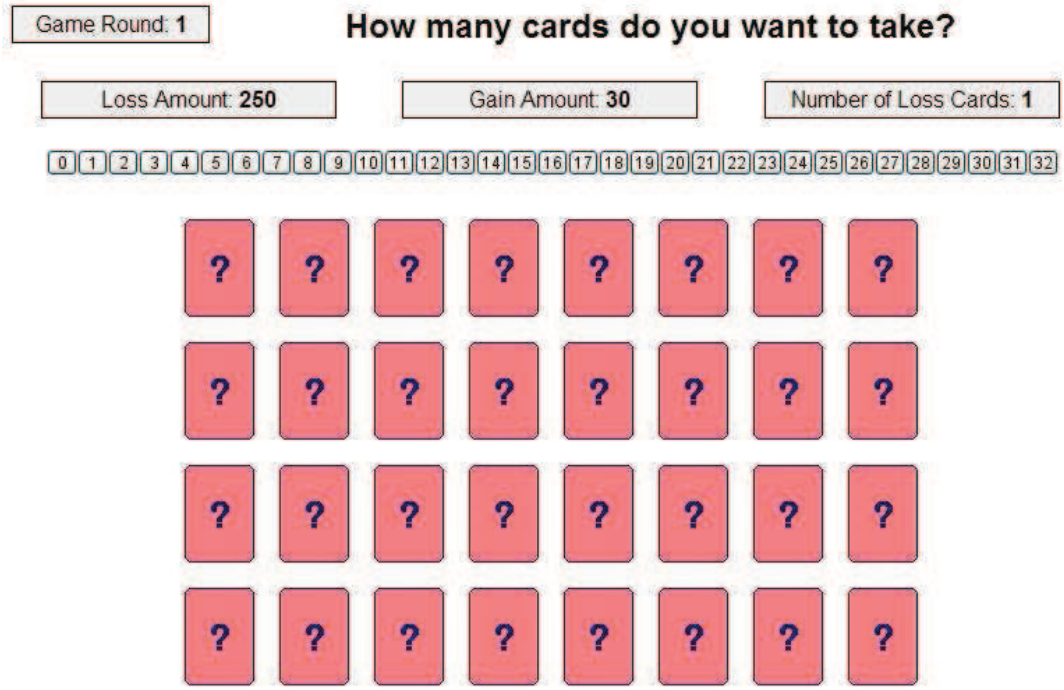
Note. a) No cards selected; b) Five cards selected

The purpose of the game is to gain as many points as possible during the 63 rounds, and the participants have to choose one card after the other until they

have decided that it is getting too risky and that it would be better to stop (Figner & Voelki, 2004). The game was designed in such a way that if the participants click on a loss card, the round immediately ends, all cards are revealed, and a new round starts. However, this characteristic makes it impossible for the authors to get the real number of cards that the participants wish to choose, since the round immediately ends when participants click on a loss card. In this sense, true risk tolerance is underestimated if the participant would have been willing to turn more cards (Huang, Wood, Berger, & Hanoch, 2013). Thus, the authors manipulated the hot condition in such way that the loss cards would always be the last possible cards in 54 rounds. To maintain the illusion of a real game of chance, the authors also added nine rounds, called losing trials, with fixed feedback, totaling 63 rounds. In these nine rounds, every participant clicked on a losing card with very high probability, independently of the choices of the participants (Figner et al., 2009; Figner & Voelki, 2004).

In 2009, Figner and collaborators presented the no-feedback cold condition. Like the hot condition, participants could have the main three pieces of information (varying in the same way), as well as the number of the current round of the game. However, as opposed to the immediate-feedback condition in which participants could choose any card he/she wanted, in the no-feedback condition participants were requested to select the number of cards (from 0 to 32), by clicking on a small button, that represented the number of cards chosen (**Figure 4**). The cards were randomly selected and the participants did not receive feedback on the round.

Figure 4.
CCT No-feedback 'Cold' condition

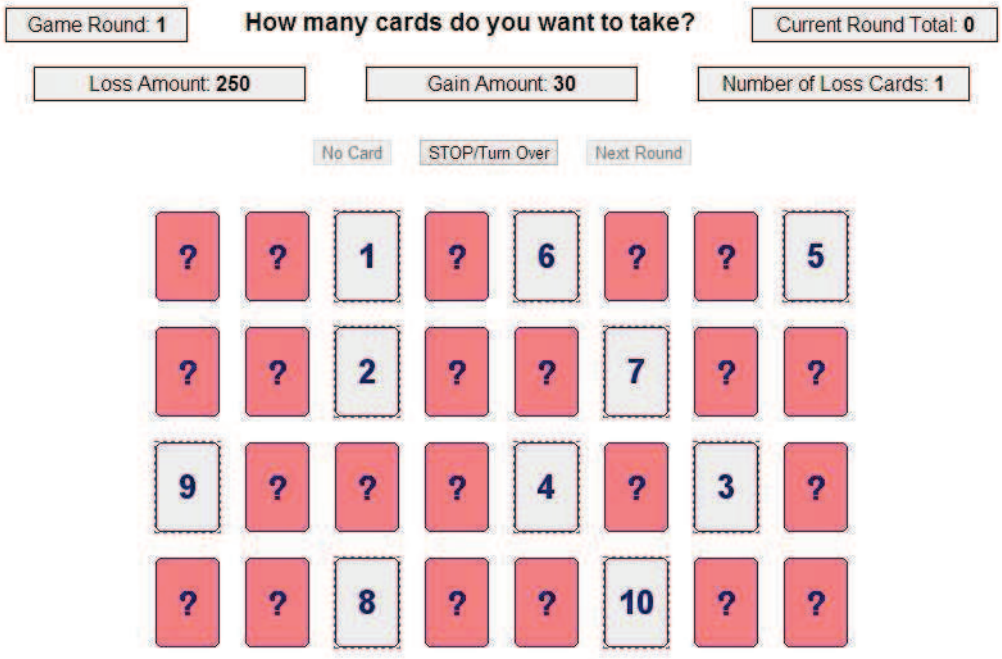


The purpose of the cold condition was also to gain as many points as possible during the entire game, but the participants had to decide how many cards they judged as too risky, making just one choice per round. Therefore, the no-feedback condition was composed of 54 rounds and was characterized by a unique choice per round and no feedback.

In order to test an alternative strategy regarding the fixed feedback, Figner developed a third condition of CCT, the delayed-feedback warm condition, tested by Huang and collaborators (2013). In the delayed-feedback condition, participants were exposed to the same main information, but with different variations: a) number of hidden losing cards (1, 3); b) amount of gain per winning card (10, 30); and c) amount of loss per loosing card (250, 750). The authors also opted for a short version of CCT, with 24 rounds for the delayed feedback. The game-play of the delayed-feedback condition was similar to the immediate-feedback condition, in which participants had to gain as many points as possible during the entire game by choosing one card after the other until they decided that it was getting too risky and that it would be better to stop. The main difference is that when a card is selected, there is no immediate feedback, since the selected card is kept as an unknown numbered card until participants voluntarily

end the round (**Figure 5**). The delayed-feedback condition maintains a dynamic choice by round but with postponed feedback.

Figure 5.
CCT Delayed-feedback 'Warm' condition.
a)



b)

Note. a) Ten cards were numbered according with the chosen order; b) When participant judge that is too risky choose more cards and voluntary end the round, all cards are turned over together;

Finally, the authors manipulated the CCT with the intention of designing a brief version. The immediate-feedback and no-feedback conditions were abbreviated to 24 rounds each.

1.4.2 CCT Previous Studies

CCT has been used to investigate decision-making, risk-taking, and information use among different periods of the lifespan, from different stages of adolescence to young and elderly adults (Figner, 2009; Huang, Wood, Berger, & Hanoch, 2013). In accordance with dual-processing models, Figner and colleagues (2009) indicated that only during affective context (i.e., the immediate-feedback 'hot' condition) adolescents take more risk than adults do and that adults use more information than adolescents do. The authors also showed that the immediate-feedback condition elicited higher emotional arousal, as indexed by electrodermal activity (EDA), when compared to the no-feedback 'cold' condition and to the baseline.

Recently, Holper and Murphy (2013) combined functional near-infrared spectroscopy (fNIRS) with EDA. Interestingly, the authors found that during the decision phase, fNIRS showed larger total hemoglobin concentration changes in cold CCT as compared to hot CCT, whereas EDA revealed larger skin conductance responses to hot CCT as compared to cold CCT (Holper & Murphy, 2013). Furthermore, based on the idea that the right dorsolateral prefrontal cortex seems involved in inhibitory control of affective impulses, while the left dorsolateral prefrontal cortex seems involved in deliberative processing of information, Pripfl and colleagues (2013) utilized transcranial direct current stimulation (tDCS) to investigate whether different stimulations influence risky choices. The authors showed that stimulation over DLPFC decreased risk-taking in cold CCT. In view of explain it, the authors discussed that because cold CCT elicits more mathematical and deliberative strategies, it is possible that the stimulation leads to a modification in the executive functioning as well as working memory performance, decreasing risk-taking (Pripfl, Neumann, Köhler, & Lamm, 2013). Taken together, these findings suggest that CCT conditions triggered different affective and deliberative strategies, supported by different physiological

techniques such as electrodermal activity, near-infrared spectroscopy, and transcranial direct current stimulation.

1.5 Present Dissertation

Dual-processing models of decision-making have been used to explain risk-taking in drug addiction and adolescence, highlighting that it might result from an imbalance between “affective” and “deliberative” processes (Gladwin et al., 2011). In addition, studies of decision-making processes in drug addiction and adolescence are of immense value, because they can help to establish common patterns of evaluation of gains, losses, and risks, as well as risk-taking behavior, which could improve treatments or even prevention strategies (Reyna & Brainerd, 2011). Despite that, few efforts have been made to investigate which aspects of the decision-making impairments in drug addiction resemble those risk behaviors during adolescence. The main aim of this dissertation is to investigate the relation of individual factors (i.e., drug addiction and adolescence) and contextual factors (i.e., feedback exposure) in decision-making processes (i.e., risk-taking behavior and evaluation of risks, gains, and losses). To achieve this goal, this dissertation is composed of three chapters described as follows.

Chapter 1 describes the first study titled “Assessing Affective and Deliberative Decision-Making: The Columbia Card Task Brazilian Version” which aimed to translate and adapt the CCT (i.e., the immediate-feedback condition, delayed-feedback condition, no-feedback condition, need-for-arousal scale and hot-cold manipulation check scale) to Brazilian Portuguese. Chapter 2, called “Crack-cocaine users take risks similar to adolescents during deliberative-based scenarios”, investigates differences and similarities between female crack users, female adolescents, and female non-user adult controls with regard to the role of feedback in risk-taking behavior and use of explicit information. Finally, Chapter 3 presents a brief overview about the two studies and finally the conclusions of the dissertation.

This dissertation was carried out in collaboration with other institutions and centers: the São Rafael Unity from the Mãe de Deus Hospital (for recruitment of female crack-dependent users) and the Escola Municipal de Ensino Fundamental Professora Judith Macedo de Araújo (for recruitment of female adolescents). All

of the ethical requirements were carefully fulfilled, and the documents reporting the approval from the Ethical Committee for Research are provided at the appendix I.

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2. CHAPTER 1

ASSESSING AFFECTIVE AND DELIBERATIVE DECISION-MAKING: THE COLUMBIA CARD TASK BRAZILIAN VERSION

3. CHAPTER 2

CRACK-COCAINE USERS TAKE RISKS SIMILAR TO ADOLESCENTS DURING DELIBERATIVE-BASED SCENARIOS

4. CHAPTER 3

GENERAL DISCUSSION

4.1 Summary of Results

The main aims of this thesis were: (1) translate and adapt the CCT to Brazilian Portuguese; (2) investigate differences and similarities between female crack users (CU), female adolescents (AD), and female adult non-users with regard to the role of feedback in risk-taking behavior and use of explicit information; and (3) investigate whether sensation-seeking, impulsivity, mood symptoms, and cognitive functioning could explain differences in CCT performance.

The first objective was achieved by Study 1, which provided an adaptation of the whole CCT, including the three conditions (immediate feedback, delayed feedback, and no feedback) and its self-reported scales to Brazilian Portuguese. We also reported a pilot study indicating that with regard to CCT outcomes and parameters, CCT conditions triggered different risk-taking behaviors and information use patterns, corroborating previous findings (1-6). Furthermore, our findings partially corroborate previous studies concerning emotional arousal responses, indicating that only the delayed-feedback (warm) condition presented higher electrodermal activity (EDA) when compared to the no-feedback (cold) condition. For example, Figner and colleagues (2009) demonstrated that the immediate-feedback (hot) condition elicited higher emotional arousal when compared to the no-feedback (cold) condition and to the baseline. However, Figner and colleagues (2009) used an extended version of the immediate-feedback condition, which was programmed (called rigged-feedback) to not show a bad card until the end of the deck, leading to successive positive cases of feedback and prolonged round time (2). We used a shorter version of the immediate feedback condition with no rigged-feedback (Buelow, 2014; Holper, 2013; Pripfl, 2013). Consequently, people received negative feedback (i.e., they flip a bad card) after they chose approximately 8 cards. It is possible that this difference also explains why people chose more cards in the prolonged version when compared to the shorter version (1, 6) (divergent findings were also found in (3). Notwithstanding, to our knowledge, no previous study compared EDA during the immediate-feedback condition and the delayed-feedback condition. Lastly, we also performed further analysis to investigate if the capacity of participants to distinguish disadvantageous scenarios predicted the number of cards chosen. This analysis indicates that the disadvantageous level predicted the number of cards chosen, suggesting that people modulate their responses according to CCT scenarios.

In the second study, we opted to identify CCT conditions by their main characteristic, which is the type of feedback (i.e., the availability of participants regarding their performance on CCT) rather than the level of emotional arousal. Moreover, during strategy use assessment in Study 1, participants did not report any significant difference regarding emotional arousal when comparing warm and hot conditions. For these reasons, throughout the dissertation we referred to CCT conditions as immediate feedback, delayed feedback, and no feedback with the exception of Study 1. This decision was also made because Study 1 suggested that the delayed-feedback condition instigated more emotional reactivity than the immediate-feedback one, prompting inconsistent conclusions about the emotional arousal elicited by the so-called hot condition.

The second and third goals were achieved by Study 2, in which the main findings suggested that the type of feedback plays a crucial role only for the CU group's risk-taking, while CG and AD maintain the same risk-taking patterns in both delayed- and no-feedback conditions. In this sense, during the no-feedback condition, which might trigger deliberative processing, both CU and AD showed higher risk-taking than CG. In the delayed-feedback condition, AD showed higher risk-taking than CU and CG. As we expected, the feedback on CCT did not modulate the risk-taking behavior of the CG group, which had the lowest risk-taking index when compared to CU and AD. With regard to the information use, our data revealed that during the no-feedback condition, information factors played a more prominent role in the number of cards chosen (significant effects were found for all information factors). Moreover, individual-level analysis revealed that probability and valence of the loss are the contextual factors that most influence decision-making; however, group analysis showed that it is the capacity to perceive gains that plays a crucial role in differentiating the non-user adults from crack users and adolescents. In addition, the self-reported questionnaire revealed that in the delayed-feedback condition, the CU group used more affective-based strategies than AD and CG, while in the no-feedback condition CU used more affective-based strategies than CG. Partial correlations with IQ as covariate showed a negative correlation for deliberative-based strategies and risk-taking for CG, but a positive correlation for deliberative-based strategies and risk-taking for AD. Additionally, information factors (probability and loss value) were positively correlated with risk-taking for AD, while only loss value was negatively correlated with risk-taking for CU.

Finally, additional partial correlations also indicated a negative correlation between the risk-taking on the delayed-feedback condition and working memory for the CU group, in accordance with previous studies (7, 8). A positive correlation was found between poorer inhibitory control and risk-taking, primarily on the no-feedback condition for the AD group. Non-planning positively correlated with risk-taking for CG in the no-feedback condition, while a negative correlation with depressive symptoms and risk-taking was found for CU in both conditions.

4.2. Additional results

To integrate the information use and risk-taking behavior and to illustrate our findings, the averages of the ranking score of information use complexity for all groups were plotted with the average number of cards chosen (Figure 1). The raw data were transformed into percentages (32 cards = 100%, number of cards chosen; 3 ranking score = 100%, information complexity).

Figure 1.
Risk-taking Index per Information Use

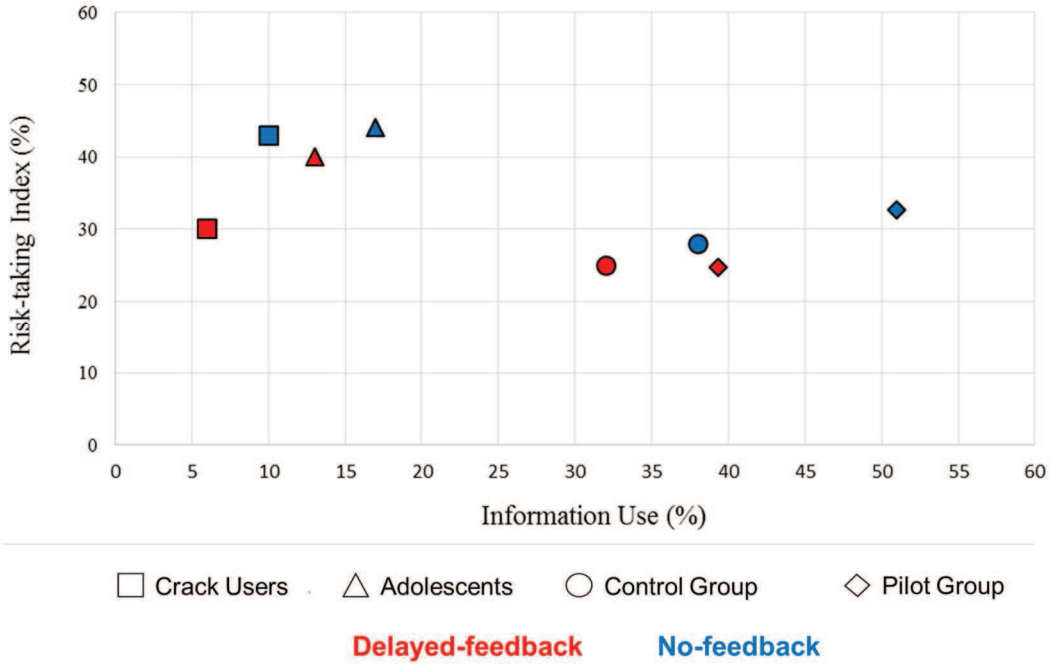

Figure 1 illustrates that when participants constantly received feedback from CCT about their own performance, they used less information, but also made less risky behaviors. Although these descriptive data depict our main findings, they must be

interpreted considering that pilot group included both male and female participants (Study 1), while the other groups were composed only of female participants. In addition, the mean age of PG was 23 years old (SD = 2.33), while CG was 29.4 (SD = 4.14), CU was 29.8 (SD = 6.34), and AD was 16 (SD = 0.76), and no inferential statistics were made comparing PG and other groups.

4.3. Conclusions

In summary, our findings support the assumption that the Brazilian version of CCT is a successful manipulation of contextual factors (feedback exposure, gain amount, loss amount, and probability of loss) influencing decision-making processes (such as risk-taking and information use) in different samples (i.e., female adolescents, female crack cocaine users, female adult controls, and male and female university students). We also showed that CCT conditions (immediate feedback, delayed feedback, and no feedback) vary according to the average number of cards chosen and emotional arousal measured by electrodermal activity and self-reported measures. Although we did not confirm that the immediate-feedback condition triggered more affective responses using electrodermal activity, we did not use the same version as Figner and colleagues (2009). In spite of that, self-reported measures are in accordance with the previous literature with regard to the affective and deliberative aspects of decision-making triggered by CCT conditions. In addition, CCT allowed us to go further than previous analyses, investigating the information use in ranking the round scenarios according to their disadvantageous level, then performing linear regressions (Study 1) and repeated measures (Study 2). Altogether, these data confirmed that CCT is a novel and versatile experimental computerized task, which could be programmed according to the theoretical backgrounds and hypotheses of researchers.

Regarding the affective and deliberative aspects of decision-making in crack cocaine users and adolescents, our main findings suggest that feedback triggered affective-intuitive reasoning and favored feedback-based learning, decreasing risk-taking in crack cocaine users, while it might have triggered more deliberative-explicit reasoning for adolescents. Thus, our findings did not support the findings of Figner and colleagues (2009), because adolescents seemed to perceive the information as less risky than female adult controls did. Despite that, we maintain that CCT can

successfully be used to access dual-processing models of decision-making, since we clearly identified that risk-taking patterns are different aspects of information use, and could be malleable depending on the type of feedback exposure.

Our findings go further than cognitive/behavioral studies on decision-making, adding a Brazilian version of CCT and performing relevant comparisons among crack cocaine users and adolescents that have been widely described under a similar dual-processes theoretical background. Moreover, we elucidated some questions about the evaluation of gains, losses, and risks among different samples, suggesting that university students have higher rates of information use, but crack cocaine users did not consider the variability of the scenarios. In general, as some descriptive theories proposed, people mostly focus on negative information, such as probability and the valence of loss. Perhaps future studies could consider manipulating CCT to show higher gains in view of instigating reward-seeking behaviors. Our data allow us to hypothesize that one of the reasons that self-help groups are one of the most efficient therapeutic remedies for drug addiction is due to the constant feedback individuals receive for their own choices that the group provides, as opposed to habitual therapeutic treatments that aim to promote long-term goals. In relation to adolescents, our findings corroborate previous studies, questioning the prevention strategies focused only on highlighting the inherent risks of certain behavior. Perhaps embracing other educational strategies focused on values (e.g., health, sports, and culture) could influence risk-taking behaviors. In addition, to our knowledge, we are the first to compare the three conditions of CCT. Future studies should aim to validate the Brazilian version of CCT among different Brazilian samples (e.g., male, different socioeconomic backgrounds, other developmental periods and clinical conditions), comparing it with different decision-making tasks, such as affective ones (Iowa Gambling Task) or deliberative ones (Game of the Dice Task) to investigate the psychometric properties of this task.

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