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Does Psychological Resilience Affect the Relationship Between Adverse Childhood Experience and Self-Regulation?

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Abstract

The present study investigated the potential effect of psychological resilience on the relationship between adverse childhood experience (ACEs) and self-regulation. There were 18 adult participants (five males and 13 females). The ages ranged from 19 to 30 (M = 23.11, SD = 3.39) years old. To measure psychological resilience, ACEs, and self-regulation, participants were required to respectively finish the Connor-Davidson Resilience Scale, the Adverse Childhood Experience Questionnaire, and the Two-Urn Task. Contrary to expectation, data analysis showed that the negative correlation between ACEs and self-regulation remained statistically significant regardless of the resilience level, suggesting that resilience did not alleviate the effect of ACEs on self-regulation. The misconceptualization of psychological resilience in the present study might contribute to the lack of moderating effect from resilience. Moreover, resilience did not correlate with ACEs, indicating that resilience develops independently from ACEs. Resilience also did not correlate with self-regulation, suggesting that resilience and coping may be two distinct constructs. Future research that could replicate and extend the present study was discussed.

Does Psychological Resilience Affect the Relationship Between Adverse Childhood Experience and Self-Regulation?

Many people have experienced childhood trauma (e.g., domestic violence) at some point in their lives. In fact, surveys suggest a high prevalence rate of childhood adversity. In the U.S., 45% of the people reported having experienced at least one episode of childhood trauma (Sacks & Murphey, 2018), and in Canada, this number rises to 64% in provinces such as British Columbia (Soares, 2017). Childhood adversity has many negative effects on people's cognitive abilities. One such effect is reflected in its influence on self-regulation, as past research showed that the ability to self-regulate could be negatively affected by the adverse experiences that people have at a young age (Evans & Kim, 2013). As it was well-demonstrated that the ability to regulate one's thoughts and emotions is an important skill for achieving long-term goals in life (Mischel, Shoda, & Ayduk, 2007), developing ways to intervene the effects of childhood trauma on self-regulation is of great importance. Although previous research has identified factors (e.g., emotional intelligence; Swopes, Simonet, Jaffe, Tett, & Davis, 2013) that could influence the effects of childhood adversity on self-regulation, one factor that has been overlooked by the literature was psychological resilience. Thus, the current study aims to investigate the effects of resilience on the relationship between childhood adversity and self-regulation (see Figure 1).

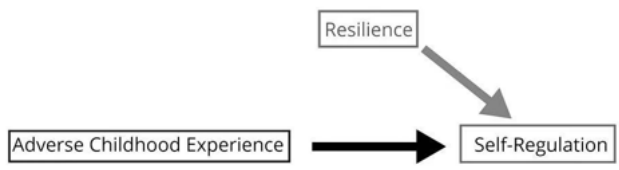

Figure 1. The rationale of the present study.

Self-Regulation

Self-regulation is the ability to control one's behaviors, thoughts, and emotions in the pursuit of long-term goals (Mischel et al., 2007). Different levels of self-regulation can be represented in terms of model-based and model-free decision-making. Individuals who possess a model-based decision-making tendency (i.e., a high level of self-regulation) are able to delay immediate gratification and know how to strategically maximize their rewards in the long run. However, individuals who possess a model-free decision-making tendency (i.e., a low level of self-regulation) are more attracted to immediate rewards and lack consideration of the long-term consequences of their actions.

Self-regulation is a topic worth studying because model-based decision-making is related to a range of competencies throughout childhood, adolescence, and adulthood, and these competencies may help to obtain better achievement. Mischel, Shoda, and Rodriguez (1989) conducted a longitudinal study to investigate the effects of self-regulation on children. The researchers found that the children who could delay immediate gratification grew up to be more skillful individuals. For example, after those children became adolescents, they were rated as more socially and cognitively competent than their peers. They were also more able to manage stress and displayed better self-control in frustrating situations compared to those who were less able to self-regulate. Moreover, when the children reached their early 30s, a follow-up study conducted by Ayduk et al. (2000) revealed that the correlations remained significant between the children's ability to delay short-term rewards and adult-relevant measures of social-cognitive competence, self-regulatory abilities, goal-setting, and planning. These developed competencies may then help to obtain better academic achievement. For example, Shoda, Mischel, and Peake (1990) found that the children who could delay immediate rewards later obtained substantially

higher SAT scores than those who were prone to instant gratifications. Moreover, Duru, Duru, & Balkis (2014) showed that self-regulation could positively predict undergraduates' academic achievements. What's more, self-regulation is related to job performance. For example, Porath and Batemen (2006) found that having better self-regulation could positively predict sales performance among salespeople. Wallace and Chen (2006) also found that self-regulation was positively related to occupational productivity.

As self-regulation is related to a range of cognitive competencies and that they may help to obtain better academic and occupational achievements, it is important to devote resources to investigate the topic of self-regulation.

Adverse Childhood Experience and Self-Regulation

Adverse Childhood Experiences (ACEs) can be defined as the negative, stressful, or traumatizing events that occur before the age of 18 (Dube et al., 2003). ACEs include childhood traumas such as exposure to domestic violence, parental separation, and household mental illness, etc. It has been demonstrated that ACEs have a high prevalence rate (Sacks & Murphey, 2018; Soares, 2017).

Furthermore, by examining the impacts of ACEs, past research found that ACEs could increase an individual's model-free decision-making tendency. For example, Evans and Kim (2013) found that the children who lived in poverty had more self-regulatory deficits. Their teachers and parents rated the children as less able to self-control, as more impulsive, and as having more attentional-control problems. More importantly, the effect of ACEs could be reflected on a neurobiological level. To demonstrate, Kamkar, Lewis, van den Bos, and Morton (2017) examined the brain activities during reward-based learning in children who were exposed

to adversities. The results showed that the link between ACEs and reward-based learning was related to the activity in the ventral striatum (VS) in the brain. The VS is a brain region that is associated with dopaminergic activities and rewards. The authors explained that early childhood adversities might lead to hyper-dopaminergic functioning in the VS. As a result, people who had ACEs might release more dopamine in the brain, which made them more sensitive to immediate rewards and behaved more impulsively. Thus, there is neurobiological evidence that shows how ACEs lead to an increasing level of model-free decision-making.

Therefore, given the negative effects of ACEs on self-regulation and the demonstrated high prevalence rates of ACEs, it is vital to develop methods that can alleviate the impact of ACEs on self-regulation.

Resilience, Adverse Childhood Experience, and Self-Regulation

In order to reduce the influence of ACEs on self-regulation, it is essential to find factors that can affect the link between the two variables. Over the past years, some of these factors have been identified. To name a few, factors that can influence the effects of ACEs on self-regulation include dispositional mindfulness (Whitaker et al., 2014), emotional intelligence (Swopes et al., 2013), social support (Olvera, 2018), and genetics (Poole, Dobson, & Pusch, 2017).

However, the majority of the research on the relationship between ACEs and self-regulation has overlooked psychological resilience. There are competing views in terms of how to conceptualize resilience (Aburn, Gott, & Hoare, 2016), but as a personality trait, it can be viewed as "the personal qualities that enable one to thrive in the face of adversity" (Connor & Davidson, 2003, p. 76). The present study follows the trait definition because the effect of ACEs on self-regulation can start early in a child's development (Evans & Kim, 2013). If resilience can

effectively alter the outcome of self-regulation when the children become adults, resilience presumably should also start its effect early on and stably protect the children across development, as early interventions have practical long-term preventive effects (Durlak, 2003).

Given the importance of self-regulation in achieving long-term goals, the present study focuses on whether resilience can improve self-regulation and hinder the impacts of ACEs on the ability to self-regulate. If indeed resilience does have an impact on self-regulation, it may be possible for researchers to develop interventions to enhance resilience among the individuals who have ACEs, and hence, to promote a model-based decision-making tendency. Given the demonstrated effectiveness of early intervention (Berlin, Brooks-Gunn, McCarton, & McCormick, 1998), enhancing resilience may prevent children who are experiencing adversities from possessing poor self-regulation in the first place. But, interventions for resilience are not limited to children, as growing evidence suggests that there are opportunities to enhance resilience across the life span (Feder, Torres, Southwick, & Charney, 2019). This leads to the possibility that people with ACEs from all age groups are able to strengthen resilience to improve self-regulation. As such, it is valuable to investigate how resilience affects self-regulation under the influence of ACEs.

Nevertheless, to test if resilience can change the outcome of self-regulation, we should specifically examine the relationship between resilience and self-regulation. Generally speaking, evidence suggests that self-regulation may be associated with trait resilience because of the cognitive flexibility used in processing emotional materials. As self-regulation enables the pursuit of long-term goals (Mischel et al., 2007), cognitive flexibility may relate to self-regulation in two ways (Hofmann, Schmeichel, & Baddeley, 2012). Firstly, when pursuing a long-term goal, cognitive flexibility allows an individual to abandon suboptimal means and to

pursue alternative means (i.e., means-shifting). Secondly, cognitive flexibility allows an individual to disengage from a goal and to pursue tempting alternatives in order to achieve an adaptive balancing of self-regulatory goals and short-term gratifications (i.e., goal-shifting). As such, cognitive flexibility plays a role in self-regulation. Furthermore, research found that cognitive flexibility is connected to resilience by promoting "flexible affective processing," which enables a person "to switch back and forth between processing the affective versus non-affective qualities of affective information" (Genet & Siemer, 2011, p. 381). Hence, in order for the resilient individuals to make adaptive responses to stressors, they need to disengage from the affective qualities of information that elevate impulsivity, as well as attend to the non-affective qualities that promote rationality. Therefore, because psychological resilience is connected to cognitive flexibility (through flexible affective processing) and that cognitive flexibility is linked to self-regulation (through means-shifting and goal-shifting), it is likely that resilience is positively correlated with self-regulation.

The Present Study

The present study by far has reviewed how self-regulation respectively relates to ACEs and resilience. The assessment of the relationships among the variables requires specific measures. Adult participants will be recruited for the assessment as the present study focuses on the outcome of self-regulation when people have developed into adults.

Firstly, to evaluate the level of resilience, the present study uses the Connor-Davidson Resilience Scale (CD-RISC-10; Connor & Davidson, 2003). On a scale from 0 to 4, participants rate how well each item describes them. A higher total score of the items means the participants possess a higher level of resilience and vice versa.

Next, the present study uses the Adverse Childhood Experience Questionnaire (ACE Questionnaire; Dube et al., 2003) to measure the level of ACEs. In the questionnaire, participants answer 'Yes' or 'No' to items that describe their experience with childhood adversity. The questionnaire at last generates a score. A higher score means the participants have had more ACEs and vice versa.

Lastly, the current study applies the Two-Urn Task (Fischer, Bourgeois-Gironde, & Ullsperger, 2017) to measure the level of self-regulation. In each trial of the task, participants choose one of two urns, and the chosen urn provides a feedback value, which is either positive, negative, or zero. Moreover, either one of the urns can be good or bad, and either urn can produce positive or negative feedback values. However, the good urn overall is more likely to produce positive feedback values. Participants' goal is to get as many positive values as possible. The probability distributions of how likely a good or bad urn produces certain values are provided to participants. This is to help them infer which urn is the good urn by matching the received feedback values to the probability distributions. After each time participants receive a feedback value by choosing an urn in a trial, they will indicate how likely they believe the chosen urn is good on a scale from 0 to 100. As the same set of urns are used across trials, they will receive more feedback values by choosing a certain urn, and thus, they should be able to update their beliefs about how likely an urn is good. There exists an ideal pattern of updating beliefs that represents a perfect level of self-regulation, and a comparison between the ideal pattern and a participant's pattern generates a beta value. High beta values suggest a model-based decision-making tendency, and low beta values suggest a model-free decision-making tendency.

Based on the reviewed evidence, experiencing more ACEs is related to a lower level of self-regulation. But, when the level of resilience is high, the level of self-regulation may be elevated. Thus, the presence of a high resilience level may attenuate the correlation between ACEs and self-regulation. Therefore, the present study hypothesizes that the scores on the CD-RISC-10 can affect the correlation between the scores on the ACE Questionnaire and the beta values generated by the Two-Urn Task. The present study predicts the following: when the scores on the CD-RISC-10 are low, high scores on the ACE Questionnaire will be related to low beta values in the Two-Urn Task; when the scores on the CD-RISC-10 are high, the scores on the ACE Questionnaire will not be significantly related to the beta values in the Two-Urn Task.

Method

Participants

The present study had 18 participants. Only adult participants were included. The age ranged from 19 to 30 (M = 23.11, SD = 3.39) years old. Of the participants, there were five males and 13 females. All participants were recruited through posters placed around the university campus. No participant was excluded since all of them successfully finished all procedures. The study was approved by Western University's Research Ethics Board (see Appendix A).

Materials

Demographics. Participants were asked to complete a questionnaire that inquires basic demographic information, including age and gender. Providing demographic information takes five min to finish.

Psychological Resilience. The Connor-Davidson Resilience Scale (CD-RISC-10; Connor & Davidson, 2003) was applied to assess the level of resilience. The scale contains 10 test items.

Sample items include “I am able to adapt when changes occur” and “Having to deal with stress can make me stronger.” Respondents were asked to indicate how accurate each test item matches their true selves on a 4-point scale ranging from 0 (*not true at all*) to 4 (*true nearly all the time*). All individual scores were then summed up to generate a final score to represent the level of resilience. A high final score suggests a high level of psychological resilience and vice versa. The scale takes about 10 min to finish. The reliability of the scale has been demonstrated with a Cronbach’s alpha of .84.

Adverse Childhood Experience. The level of childhood adversity was assessed using the Adverse Childhood Experience Questionnaire (Dube et al., 2003). The questionnaire has 10 test items. Sample items include “Were your parents ever separated or divorced?” and “Was a household member depressed or mentally ill or did a household member attempt suicide?” Participants were required to answer “Yes” or “No” to each test item. Answering “Yes” to a test item was scored as 1, whereas answering “No” to a test item was scored as 0. Lastly, all the scores were added up to generate a final score to represent the level of adverse childhood experience. A high final score suggests a high level of adverse childhood experience and vice versa. The questionnaire takes about 10 min to finish. The reliability of the questionnaire has been demonstrated with a Cronbach’s alpha of .78.

Self-Regulation. The Two-Urn Task (Fischer, Bourgeois-Gironde, & Ullsperger, 2017) was used to assess individuals’ variability in model-free relative to model-based decision-making. This was used as an index of self-regulatory behaviors in that model-based decision-making represents a high level of self-regulation, whereas model-free decision-making represents a low level of self-regulation. The Two-Urn Task was chosen for the current study because the original authors (Fischer et al., 2017) found concrete neurobiological evidence to

support the validity of the task. By using functional magnetic resonance imaging (fMRI), it was demonstrated that while participants were performing the task, model-based decision-making correlated with dorsal striatal and frontopolar cortex activity, and model-free decision-making associated with ventral striatum activity. The results were consistent with previous research on similar brain regions (Everitt, & Robbins, 2005).

Nonetheless, in terms of task procedure, prior to starting the task, participants were advised that they could win up to $20 (CAD) depending on how many points (in the form of feedback values) were accrued during the task. This was to motivate participant engagement. To maximize monetary gain, the participants' goal was to obtain as many positive feedback values as possible to maximize the final score (the final score was calculated by adding up all the feedback values). This could be accomplished by selecting from the "good urn" more often than the "bad urn." However, to avoid their moods being affected by their performance, all participants received $20 (CAD) regardless of their final scores. At the end of the task, a screen appeared saying that participants did a "Great Job" and won $20 (CAD).

To explain the Two-Urn Task more in-depth, the task consisted of 12 blocks of 20 trials, and it took approximately 40 minutes to complete. In each trial, the task presented a yellow urn and a blue urn to participants on a computer screen (see Figure 2a). Participants were instructed to choose one of the urns. Once chosen, the urn would provide a feedback value to the participant in the form of points earned or lost. The feedback value could be positive (i.e., the participant earned points), negative (i.e., the participant lost points), or zero (i.e., the participant received zero points). Furthermore, as mentioned, the urn could be either good or bad. After receiving a feedback value in a trial, participants needed to judge how likely the chosen urn was good on a scale from 0 (*not likely at all*) to 100 (*very likely*). Information about the good and bad

urn in the form of pie charts (see Figure 2b) also continuously stayed on the screen to help make the judgment. In the current example, the pie charts show that both good and bad urns can provide the same set of feedback values (i.e., +40, +50, +60, -40, -50, and -60). But, in the good urn, these feedback values respectively has a probability of 10%, 25%, 10%, 25%, 10%, and 10% (leading to a positive expected value in the long-term), and in the bad urn, the same feedback values respectively has a probability of 25%, 10%, 10%, 10%, 25%, and 10% (leading to a negative expected value in the long-term). The distributions of the feedback values imply that keep choosing the good urn in the long-term is likely to receive overall positive feedback values, and keep choosing the bad urn is likely to receive overall negative feedback values. As such, in each trial, when judging how likely a chosen urn is good, participants needed to consider how well the feedback value of the chosen urn fitted the probability distributions of the good or bad urn. Moreover, the same set of urns were used within a block. Thus, when more trials were completed throughout a block, participants could receive more feedback values to help with their judgment of each urn (recall that each completed trial produces one feedback value). As a result, participants should update their beliefs about how good an urn was as they finished more trials within a block, and they should accordingly choose the urn that they believed was good to maximize their final score. At the end of each block, participants were asked to make a final judgment about whether an urn was good or bad (see Figure 2c). A correct judgment would add five bonus points to participants' final scores, and an incorrect judgment would deduct five points from the final scores. Choosing "I don't know" would not affect the final score. Thereafter, the cumulative points earned (i.e., the sum of all the feedback values) were displayed.

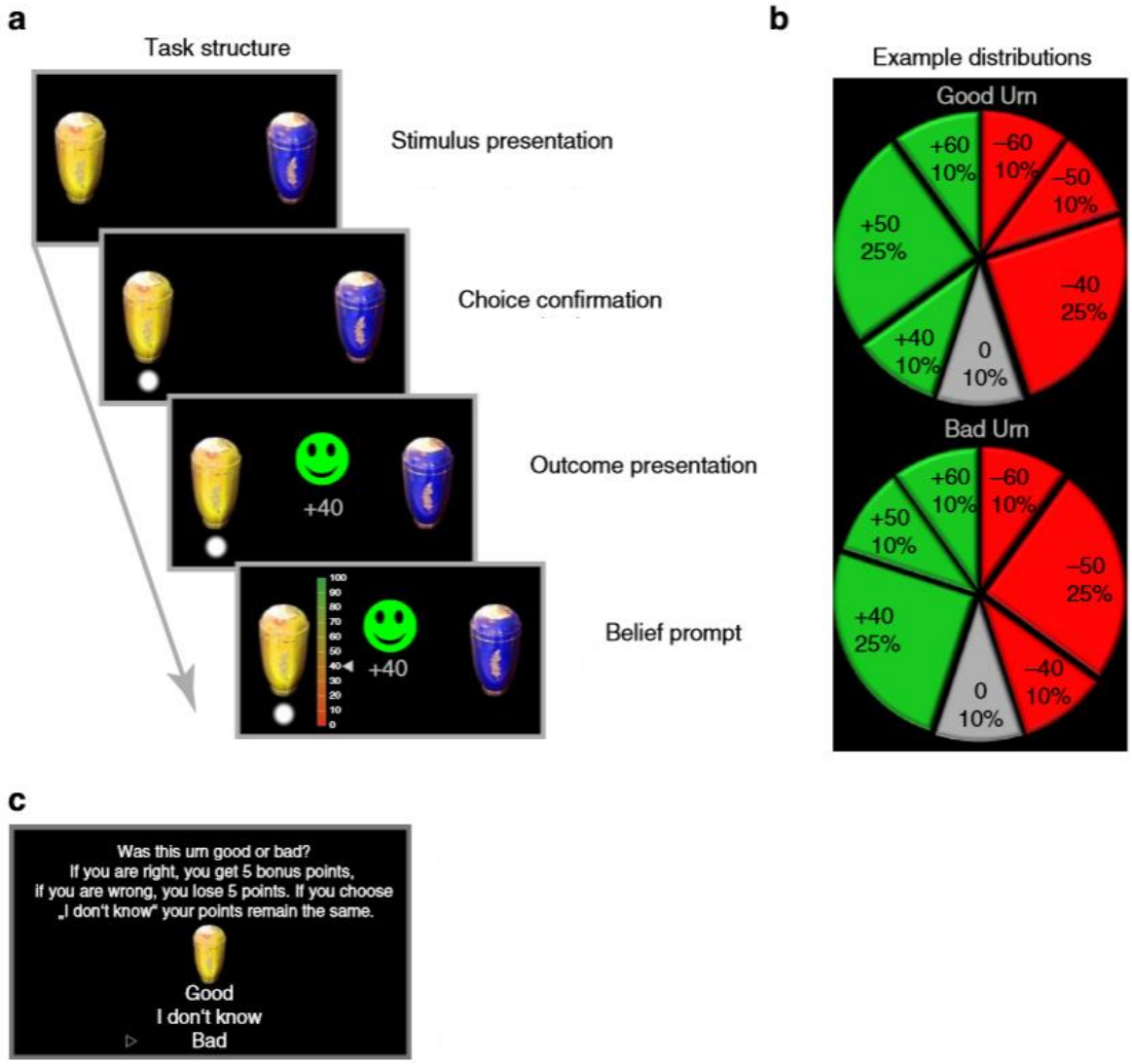

Figure 2. Task design. (a) Schematic of an example trial. (b) example probability distributions of a good urn and a bad urn. (c) The final question about whether an urn is good or bad.

The evaluation of the level of self-regulation (i.e., model-free vs. model-based decision-making) was based on how well the participants updated their beliefs about an urn across trials by matching the received feedback values with their associated probability distributions. To provide an example of the evaluation, assume that participants receive a +40 in the first trial after choosing the yellow urn. A person who possesses a high level of self-regulation (i.e., model-

based decision-making) should believe that the yellow urn is not likely to be good because the bad urn has a higher chance (i.e., 25%) than the good urn (i.e., 10%) to produce a +40. But, a person who has a low level of self-regulation (i.e., model-free decision-making) may believe that the yellow urn is likely to be good because he or she focuses more on the short-term reward (i.e., a +40 immediately increases the final score), but not the long-term consequences (i.e., the probability distributions in the pie charts). However, after the first trial, assume that the yellow urn produces a -40 throughout the second to fourth trial. In this scenario, a person with a model-based decision-making tendency should update his belief and think that the yellow urn is likely to be good even if it produces a +40 in the first trial. This is the case because the good urn has a higher chance (i.e., 25%) than the bad urn (i.e., 10%) to produce a -40, and the yellow urn has produced a -40 three times consecutively. Thus, choosing the yellow urn in subsequent trials more frequently is likely to maximize the final score. However, a person with a model-free decision-making tendency is less likely to properly update his beliefs to make optimal decisions as he focuses less on the probability distributions of the feedback values.

The Two-Urn Task applies a Bayesian framework to model an ideal pattern of updating, which represents a perfect model-based decision-making tendency. Participants' actual updates were being compared against the Bayesian model to measure how much they deviate from the ideal update. This comparison generates beta values (range from -1 to 1) to represent different levels of self-regulation. Specifically, high beta values represent a model-based decision-making tendency, and low beta values represent a model-free decision-making tendency.

Procedure

The present study was conducted in a testing room in a research building at Western University. All measures were implemented using a computer, and each participant completed

the study individually. Upon arrival, participants received a letter of information (see Appendix B) and a consent form (see Appendix C). The study session began after the consent form was signed by participants.

Participants firstly provided demographic information to a questionnaire. Next, the Two-Urn Task was administered to participants. Right after the completion of the Two-Urn Task, participants were told that deception was involved, and they would be given an extra $20 (CAD) regardless of their performance on the task. Participants were immediately debriefed because we did not want participants' responses to subsequent measures to be affected by their moods if they performed poorly on the Two-Urn Task. After the debriefing, participants finished the Adverse Childhood Experience Questionnaire and the Connor-Davidson Resilience Scale. In total, each study session took approximately 65 min to finish, and participants were compensated with $45 (CAD). Lastly, after signing the debriefing form (see Appendix D) and compensation form (see Appendix E), participants were allowed to leave.

Results

The current study investigates the effect of psychological resilience on the relationship between ACEs and self-regulation. All data were analyzed using SPSS v.25. Because of the low sample size (i.e., n = 18), any of the results should be interpreted with caution. Nonetheless, as seen in Table 1, participants' levels of ACEs (M = 2.44, SD = 2.55), self-reported resilience (M = 29.50, SD = 4.77), and self-regulation (M = -.03, SD = 0.17) were measured. Moreover, participants' levels of ACEs are summarized in Figure 3, and the levels of resilience are summarized in Figure 4.

Table 1

Participants' level of self-regulation, ACEs, and resilience

	M	*SD*
Self-regulation	-.03	0.17
ACEs	2.44	2.55
Resilience	29.50	4.77

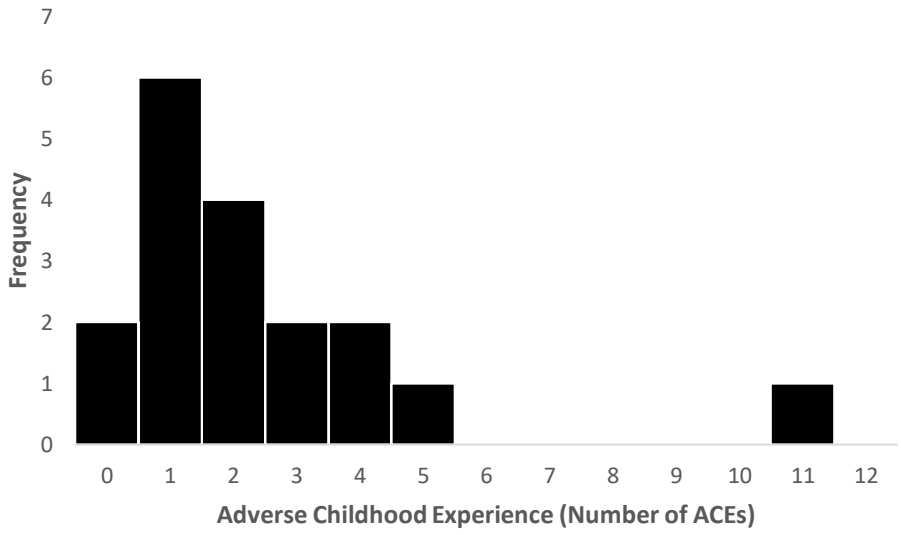

Figure 3. The probability distribution of participants' level of ACEs.

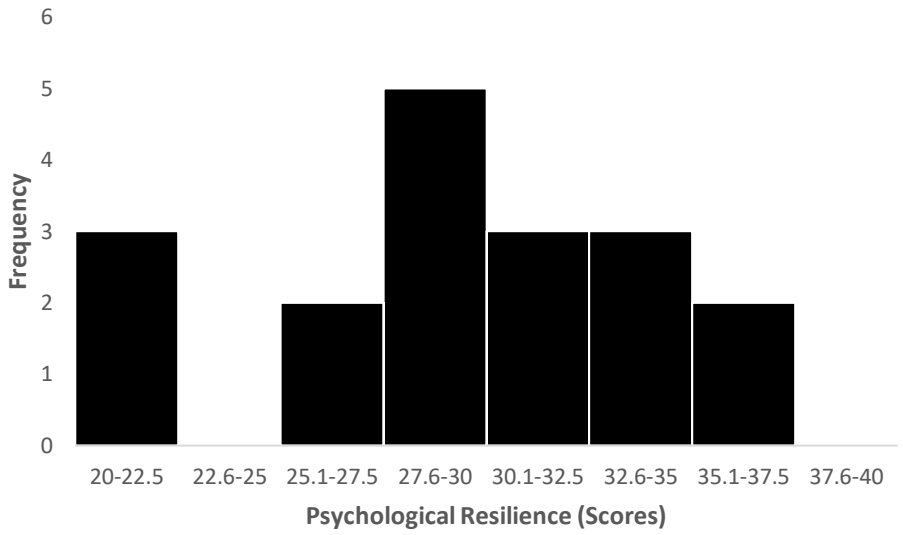

Figure 4. The probability distribution of participants' level of resilience.

A correlation analysis was conducted to analyze self-regulation, resilience, and ACEs. As seen in Table 2, the scores on the ACE Questionnaire had a large negative correlation with the level of self-regulation (i.e., the beta values) estimated from the Two-Urn Task, $r = -.59$, $p = .010$, suggesting that an increasing level of adverse childhood experiences is associated with a model-free decision-making tendency (i.e., less able to self-regulate). The correlation is also displayed in Figure 5. However, self-regulation did not correlate with self-reported resilience, $r = -.22$, $p = .387$. Also, there was no correlation between the ACEs and self-reported resilience, $r = -.08$, $p = .745$.

Table 2

Correlations among self-regulation, ACEs, and resilience

	Self-regulation	ACEs	Resilience
Self-regulation	-		
ACEs	-.59*	-	
Resilience	-.22	-.08	-

Note: *p < .05. Indicates the two variables significantly correlate.

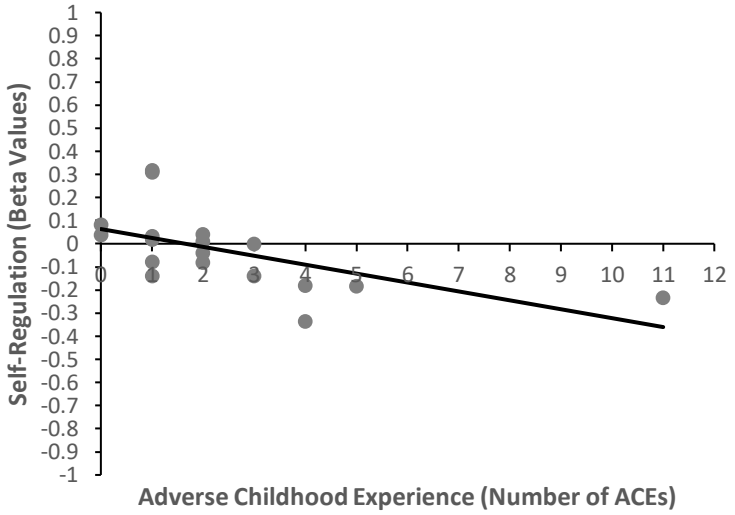

Figure 5. The relationship between self-regulation and ACEs.

A regression analysis was conducted to analyze ACEs and self-regulation. Results showed that individual scores on the ACE Questionnaire was a significant negative predictor (β = -0.59, $t(16)$ = -.2.90, p = .010, R^2 =.35) of the levels of self-regulation (i.e., the beta values), indicating that individuals that were exposed to higher levels of childhood adversity acted in a model-free rather than model-based manner when making decisions on the Two-Urn Task (i.e., lower level of self-regulation). Indeed, 35% of the variance in the beta values could be explained by individual differences in childhood adversity exposure.

Furthermore, a series of regression analyses were conducted to assess the moderating effect of resilience on the relationship between ACEs and self-regulation. All variables were centered prior to conducting any regression analyses. In the first step, beta values were entered as the criterion variable, and scores on the ACE Questionnaire and the Connor-Davidson Resilience Scale were entered as predictor variables. In the second step, the ACEs × resilience was entered as a predictor. Results showed that the interaction between resilience and ACEs was not significant ($\beta = 0.002$, $t(14) = .038$, $p = .970$, $R^2 = .006$), suggesting that the presence of resilience did not alter the relationship between ACEs and self-regulation.

The present study recognized the effect of potential outliers on data. However, after removing the data points that could potentially be outliers, a re-analysis of the data showed that the results were consistent with the original findings, which indicates that the present study did not contain outliers in data.

Discussion

The present study hypothesized that the presence of resilience could affect the correlation between ACEs and self-regulation. It was predicted that when the resilience level was low, people who experience more ACEs would have a low level of self-regulation and that when the resilience level was high, the correlation between ACEs and self-regulation would be attenuated. Contrary to expectation, it was found that, regardless of the resilience level, experiencing more ACEs tends to make people less able to self-regulate, suggesting that resilience does not influence the relationship between ACEs and self-regulation.

The lack of evidence to support the hypothesis of the present study could be due to a misconceptualization of psychological resilience. The present study adopted the view that

resilience is a stable personality trait in which it is consistent across time and situations. However, resilience has also been conceived as a process that changes over time. For instance, Luthar, Cicchetti, and Becker (2000) defined resilience as a "dynamic process encompassing positive adaptation within the context of significant adversity" (p. 543). From this perspective, the time and situation that stressors occur play a role, in that even if an individual reacts very positively to stressors at one point in time, the individual may not necessarily react in the same manner at other points in time. Moreover, there seems to be a person-environment interaction in the constitution of resilience (Egeland, Carlson, & Sroufe, 1993), so that a context that is effective in promoting resilience for one individual may not be effective for other individuals. Hence, although measuring resilience as a trait may still be relevant in terms of assessing how much resilient quality each individual possesses, when and where the resilient quality manifests itself would be different for every person.

Conceptualizing resilience as a changing process may account for why resilience had no moderating effect. Firstly, because the activation of resilience changes depends on context, the situation of taking the Two-Urn Task might not be challenging and stressful enough for participants to activate resilience as the task was merely requiring participants to respond according to a set of novel rules. Secondly, among the participants who did perceive the task as stressful, not all of them would activate resilience as different individuals react to the same stressors differently. As a result, even if we assume that it is possible for people who experience childhood adversity to develop resilience to protect their self-regulation, resilience may not be present in every individual in the context of taking the Two-Urn Task. Therefore, the conceptualization that resilience is a dynamic process gives us some insights into why it did not moderate the relationship between ACEs and self-regulation.

Implications

First of all, the present study found a statistically significant relationship between ACEs and self-regulation. Thus, the result is consistent with previous findings that ACEs could negatively influence an individual's cognitive functioning (Ritchie, 2011). Additionally, the correlation between ACEs and self-regulation in the present study is large, suggesting that the effect of ACEs on self-regulation should not be underestimated. However, since no moderation effect of resilience on ACEs was found, intervening the effect of ACEs on self-regulation may still need to rely on previous findings such as increasing perceived social support (Olvera, 2018) and improving emotional intelligence (Swopes et al., 2013).

Moreover, the fact that ACEs did not correlate with psychological resilience in the present study indicates that resilience develops independently from childhood adversity. Although there is evidence that experiencing a moderate level of adversity is helpful for a person to develop resilience (Seery, Leo, Lupien, Kondrak, & Almonte, 2013), the current finding suggests that the people who experience a high level of childhood adversity are not necessarily unable to become resilient, as there was no relationship between resilience and ACEs. This leaves open the possibility for all the people who have experienced childhood trauma to cultivate resilience through intervention. Furthermore, the current result is inconsistent with Philippe, Laventure, Beaulieu-Pelletier, Lecours, and Lekes (2011)'s finding that ego-resiliency mediates the relationship between childhood trauma and psychological symptoms (i.e., anxiety, depression, and self-harm behaviors). Resilience as a mediator needs to correlate with the level of childhood trauma. However, the lack of correlation between resilience and ACEs in the present study suggests that ego-resiliency does not mediate the relationship between traumatic childhood experience and the psychological symptoms.

Lastly, we found that psychological resilience and self-regulation had no correlation, suggesting that being resilient is unrelated to how well people control their thoughts, emotions, and behaviors when pursuing a long-term goal. This may aid the understanding of resilience. From a stress-coping perspective, some researchers assert that coping with adversity is essential to being resilient (Clauss-Ehlers, 2008; Leipold & Greve, 2009). Moreover, it has also been suggested that the coping process of stressors is closely related to self-regulation (Aspinwall, 2004). Thus, it seems likely that there should be a correlation between resilience and self-regulation. However, this was not supported by the current finding. The lack of correlation between resilience and self-regulation may be consistent with the notion that resilience and coping are two distinct processes. For example, although some people might use "resilience" and "coping" interchangeably, Fletcher and Sarkar (2013) argued that the two constructs are conceptually distinct in that "resilience influences how an event is appraised, whereas coping refers to the strategies employed following the appraisal of a stressful encounter" (p. 16). Therefore, the current finding may give some insights into the conceptualization of resilience.

Limitations and Future Directions

The present study could be underpowered because of the low sample size. Thus, the results of the present study should be interpreted with caution, and future research should replicate the present study with a larger sample size to increase statistical power.

Moreover, as previously mentioned, resilience might be a changing process, so participants' resilient qualities might not be present when completing the Two-Urn Task. Thus, on top of replicating the present study, a new study can implicitly prime resilient concepts (e.g., perseverance) before the presentation of each trial during the Two-Urn Task, as the priming effects may help to induce the resilient qualities within participants. Specifically, for the new

study, future researchers can have a group of participants that receive the prime and a group that does not receive the prime. The group that does not receive the prime should find no moderating effect for resilience as it is a direct replication of the present study. But, if the presence of resilience indeed has a moderating effect, then in the group who receives the prime, the individuals who have a high level of ACEs and have high scores on the resilience scale should show a model-based decision-making tendency. However, among the individuals that receive the prime, the people who have a high level of ACEs but low scores on the resilience scale should display a model-free decision-making tendency, because low scores on the resilience scale may indicate that they lack the resilient qualities to be activated by the priming effects. If this is indeed what future researchers find, there should still be evidence that, at least in the short-term, the presence of resilience may change the relationship between ACEs and self-regulation.

Furthermore, although the Two-Urn Task demonstrated high validity in terms of measuring model-based and model-free decision-making, some fairly complex procedures were involved. Participants who did not have a thorough understanding of abstract concepts such as probability distribution might find it difficult to complete the task. Therefore, on top of using the Two-Urn Task when measuring self-regulation, future researchers can utilize other less complicated measures. For example, the Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999) has relatively simple procedures to assess participants' level of impulsivity. For each test item, respondents choose between a smaller immediate monetary reward (e.g., $19 today) and a larger, delayed monetary reward (e.g., $25 in 53 days). Administering the Two-Urn Task along with other simpler measures can increase the convergent validity of measurement and the data can represent self-regulation more accurately.

Conclusion

The present study investigated the effect of psychological resilience on the relationship between adverse childhood experience and self-regulation. Contrary to our hypothesis, the presence of resilience did not influence the relationship between adverse childhood experience and self-regulation. Results indicated that regardless of the resilience level, childhood adversity tends to make people less able to self-regulate. This finding could be attributed to a misconceptualization that resilience should be regarded as a changing process instead of a stable personality trait. Future research can replicate and extend the present study by using the priming effects to induce resilient qualities in participants. Moreover, using a simpler measurement of self-regulation such as the Monetary Choice Questionnaire along with the Two-Urn Task may increase the accuracy of measuring self-regulation.

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Appendix A

The Ethics Approval

Western Research

Date: 30 May 2019

To: Prof. J Bruce Morton

Project ID: 114026

Study Title: Determining the neural basis underlying individual differences in reward-learning and decision-making

Application Type: HSREB Initial Application

Review Type: Delegated

Full Board Reporting Date: June 21, 2019

Date Approval Issued: 30/May/2019

REB Approval Expiry Date: 30/May/2020

Dear Prof. J Bruce Morton

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
ACE and demographics Adult	Paper Survey	26/Apr/2019	
ACE and demographics Parent	Paper Survey	26/Apr/2019	
AssentLetter	Assent Form	15/May/2019	
BisBas	Paper Survey	26/Apr/2019	
Debriefing form_Ver1-Adult	Debriefing Letter	26/Apr/2019	
Debriefing form_Ver1-Child	Debriefing Letter	26/Apr/2019	
Debriefing Script_adults	Debriefing Letter	26/Apr/2019	Verbal

Debriefing Script_children	Debriefing Letter	26/Apr/2019	Verbal
Examples of the computer tasks	Other Data Collection Instruments	26/Apr/2019	
Health Behaviour Questionnaires	Paper Survey	26/Apr/2019	
LOI ID Study Adult consent Version Date	Written Consent/Assent	23/May/2019	
LOI ID Study Child consent Version Date	Written Consent/Assent	15/May/2019	
Parent consent form	Written Consent/Assent	23/May/2019	
Recruitment Poster Adult	Recruitment Materials	26/Apr/2019	
Recruitment Poster Children	Recruitment Materials	26/Apr/2019	
Recruitment_Email_Script_adult	Email Script	15/May/2019	
Recruitment_Email_Script_child	Email Script	15/May/2019	
Resting State Scan Examples	Other Data Collection Instruments	26/Apr/2019	
Script for Social Media Posts	Recruitment Materials	26/Apr/2019	
Script for Social Media Posts Adults	Recruitment Materials	26/Apr/2019	
Study Protocol	Protocol	14/May/2019	
TelephoneScript_ADults	Telephone Script	15/May/2019	
TelephoneScript_Child	Telephone Script	15/May/2019	
Trait Food Behaviour Questionnaires	Paper Survey	26/Apr/2019	

Documents Acknowledged:

Document Name	Document Type	Document Date
List of Resources	Other	15/May/2019

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Karen Gopaul, Ethics Officer on behalf of Dr. Joseph Gilbert, HSREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix B

Letter of Information

Title of Research: **Determining the neural basis underlying individual differences in reward-learning and decision-making**

Research Investigator:
Dr. J. Bruce Morton
Department of Psychology
Western University
E-mail: bmorton3@uwo.ca

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 "Determining the neural basis underlying individual differences in reward-learning and decision-making". You are being asked to participate in this study because you are a healthy right-handed 18-30 year old, or a university student under the age of 18, that is fluent in English and has normal or corrected-to-normal vision. In this study, we are interested in examining how differences in brain connections between different regions influence how we make decisions when presented with short-term and long-term rewards.

This study is voluntary. If you agree to participate, we will ask you to come in for two study sessions. In the first session, you will complete some computer tasks and questionnaires. In the second session, you will participate in the actual imaging procedure where your brain is imaged using a magnetic resonance imaging (MRI) scanner. Magnetic resonance imaging is a non-invasive technique that does not involve injections, x-rays or radiation. During the scanning procedure, you will be asked to relax and look at different pictures while in the scanner. The first session will take place at the Western Interdisciplinary Research Building, the second session at the MRI scanner located in the Robarts Research Institute.

Study procedure

Session 1: The first session will be held in the Western Interdisciplinary Research Building and is expected to take up to 2 hours. You will be asked to complete some cognitive and food-choice tasks on the computer.

Specifically, you will be asked to do the following:

1. You will be asked to complete some computer tasks that will measure how you make decisions. The tasks will involve you selecting between different amounts of money or food items, completing some computer games designed to assess cognition, and selecting between two-urns.
2. Next you will have the chance to win a food item by bidding money on different food items. At the end of the task, if your bid is higher than the computers, you will win that food item.

2 Version Date: 30/09/2019

3. Following the food bidding task, you will be asked to hit a button on the keyboard to receive chocolate candies (M & M's). To get a chocolate you have to hit the key a certain number of times.
4. When the tasks are done, you will be asked to complete some questionnaires. In addition, we will ask to measure your height (using a tape measure) and weight (using a scale).

Session 2 The MRI scanning will occur in the second visit. You can choose not the participate in this session for any reason. This session will take place at the Robarts Research Institute. We will meet you in the lobby of the University Hospital 15 minutes prior to your scheduled appointment.
For the MRI scanning protocol:
1. You will complete a checklist to make sure that you can safely enter an MRI scanner
2. You will use earplugs to protect your ears from the noise of the scanner
3. Foam will be packed around your head to help keep it still.
4. You will lie on your back on a well-padded bed on the scanner. Pillows will be placed under your legs for comfort and a blanket will be provided if desired. When we are ready, the bed will slide into the scanner.
5. You will be asked to keep still while images are taken for approximately 45 minutes, during which multiple different scans will be taken.
6. Inside the scanner, you will be asked to relax and look at some different pictures. During some scans, you do not need to do anything. You will get specific instructions outside the scanner room.
7. During the scanning you will have to lie still, but will be able to speak to someone from time to time.

The actual scanning will take approximately 60 minutes. You will be given a 10-minute break half-way through. The entire visit will take approximately 1.5 hours from the time you arrive at the University Hospital until the time you leave.

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 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.

Inclusion/Exclusion criteria 3 Version Date: 30/09/2019

Persons between the ages of 18-30 years, who are right-handed individuals with normal or corrected-to-normal vision are eligible to participate in this study. Persons must be fluent in English to participate in the study. Persons that have been diagnosed with any neurological or psychiatric disorders (e.g., depression, anxiety, bipolar disorder), and/or have a history of head trauma, must not participate in the study.

MRI exclusion criteria

If you have any history of injury involving metal fragments, if you have some type of implanted electric device (such as a cardiac pacemaker), if you have severe heart disease (including susceptibility to arrhythmias), if you have a hearing impairment or developmental delay, if you are wearing metal braces, [for women] if you have an intrauterine device or if you suspect you are pregnant, you should not have an MRI scan.

If you have any questions regarding your eligibility, please ask the researcher now.

Safety concerns

This study involves a research test with a Magnetic Resonance Imaging (MRI) system, a common medical diagnostic tool that uses a strong magnetic field, a low frequency magnetic field, and a radio frequency field. No X-rays are used. There are no known biological risks associated with MR imaging. Some people cannot have an MRI because they have some type of metal in their body. For instance, if you have a heart pacemaker, artificial heart valves, metal implants such as metal ear implants, bullet pieces, chemotherapy or insulin pumps or any other metal such as metal clips or rings, they cannot have an MRI. During this test, you will lie in a small closed area inside a large magnetic tube. Some people may get scared or anxious in small places (claustrophobic). An MRI may also cause possible anxiety for people due to the loud banging made by the machine and the confined space of the testing area. You will be given either ear plugs or specially designed headphones to help reduce the noise

As with any technology, there is a risk of death and injury. For MRI the risk of death is less than 1 in 10 million and the risk of injury is less than 1 in 100,000. International controlled studies of human brain development on relatively small sample size (546 participants) have shown no untoward effects of repeated MRIs between the ages 0 and 18. Approximately 25 million clinical MRI procedures have also been performed on children, with no obvious effects. There is, however, a small chance that an as yet unknown problem or side effect may be discovered.

These risks do not arise from the MRI process itself, but from a failure to disclose or detect MRI incompatible objects in or around the body of the subject or the scanner room. It is therefore very important that you answer all the questions on the MRI screening questionnaire honestly and fully. You may not be allowed to continue in this research study if you are unable to have an MRI scan because, for example, you have some MRI incompatible metal in your body, you may be pregnant or attempting to become pregnant, or you may have a drug patch on your skin that contains a metal foil. Should you require a medically necessary MRI scan in the future, the final decision as to whether you can be scanned will be made by a qualified physician considering all the risks and benefits. Other remote risks involve temporary hearing loss from the loud noise inside the scanner. This can be avoided with earplug protection. If you suffer from fear of small spaces (claustrophobia), you will not be able to participate in this study, since the MRI chamber is small. If this is the case, please let us know. 4 Version Date: 30/09/2019

In addition, we will ask you to complete the Adversity Children Experience questionnaire (ACE). The ACE questionnaire is a standard measure created by the World Health Organization. This questionnaire asks several sensitive questions that include experiences with war and traumatic events. However, the ACE has explicit questions that can be emotionally upsetting. 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 they do not want to answer them. If we notice that you are feeling distressed while answering this questionnaire, we will terminate testing. We will also provide you with a list of resources that you can contact if you were affected by any of the questions on the ACE.
If you are harmed as a direct result of taking part in this study, all necessary medical treatment will be made available to you at no cost. You do not waive any legal rights by signing this consent form.

Incidental Findings

The MRI scans carried out for this study are performed solely for scientific purposes. The data which is collected is not optimized to make clinical diagnoses and the research team involved in this experiment is not trained to make medical evaluations. By participating, you agree that the experimenters are not expected to arrive at a clinical interpretation of the data collected. Nevertheless, there is a small possibility that a potential abnormality might be observed – otherwise known as an incidental finding. If this occurs, you will be notified of the issue by the principal investigator of the study who will assist you with your options for following up. Investigators are not responsible for the outcome of medical follow-up or for any incurred costs during medical follow-up. By participating, you agree to the possibility of being informed about a potential incidental finding, according to the above-described procedure. If you do not agree to the potential risk of an incidental finding, you should not participate in this study

Costs and participation fees

You will be reimbursed for transportation costs if you must travel more than 20 km to Western University, and free parking will be provided**.** You will receive $50 as a thank you for your participation. You will receive half of the compensation after the first session ($20) and the other half after the second ($30). If you do not complete the entire session, you will still receive the full compensation for that session. In addition, you can earn up to $20 depending on the number of points you earn in the two-urn task. Every point you earn will equal 1 cent. Final score will be rounded up the nearest dollar.

Confidentiality

Your results will be kept confidential and will only be used for research purposes. Before you begin the study, we will collect your age and gender. All of the information you provide will be paired with a unique participant code, which will be maintained separately from any personal information that can be used to identify you. We will not publish any of your individual data; we will only publish group data and group trends. The study may also be uploaded to the Open Science Framework which will allow other researchers access to the anonymized data. All task data will be collected and stored on password-protected computers. 5 Version Date: 30/09/2019

The data that will be shared will not contain any information that could identify you. If you choose to withdraw from this study, your data will be removed and destroyed from our database. All questionnaire data will be encrypted and will be stored on password-protected computers. In accordance with Western University policy, data will be stored for a minimum of 7 years. After 7 years, we will dispose of the data, including age and gender. To dispose of data, all portable media will be destroyed using the best available methodology, and in a way that renders it impossible to reconstruct. Hard disk data will be deleted and overwritten.

If we publish any results from this study, no individual names or identifying information will be attached to the findings. You are welcome to request a copy of any results pertaining to the group trends of this study by contacting us at any time.

Please note, representatives of The University of Western Ontario Health Science Board may require access to your study-related records to monitor the conduct of the research.

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 (bmorton3@uwo.ca) or Cassandra Lowe (clowe3@uwo.ca).

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 via telephone at 519-661-3036 or via email at: ethics@uwo.ca.

This letter is yours to keep for future reference.

Western University
Faculty of Social Science, Department of Psychology
1151 Richmond Street • London, Ontario • Canada • N6A 3K7
Telephone: 519-661-2111 • Fax: 519-850-2554 • 6 Version Date: 30/09/2019

Appendix C

Consent Form

Title of Research: **Determining the neural basis underlying individual differences in reward-learning and decision-making**

Research Investigator:
Dr. J. Bruce Morton
Department of Psychology
Western University
Email: bmorton3@uwo.ca

Your signature on this form indicates that the study has been explained to you and all your questions have been answered to your satisfaction. You agree to take part in the study. You know that you can leave the study at any time

_____	_____	_____
Participants' Name (Please Print)	Signature	Date
_____	_____	_____
Name of person obtaining consent	Signature	Date

Appendix D

Debriefing Form

Determining the neural basis underlying individual differences in reward-learning and decision-making

Thank you for your participation in this study. In this study, you were asked to complete some computer tasks and an MRI scan. We are interested in examining how differences in brain connections, measured during the MRI scan, between different regions influence how we make decisions when presented with short-term and long-term rewards. More specifically, we are interested in examining how changes in the brain connections between regions as we become adults influences how we make decisions when presented with short-term (immediate) and long-term rewards. Finally, we are also interested in how these brain connections influence are food-choices.

We expect that as we age (from teenage to adulthood) the brain connectivity between frontal regions and those regions associated with reward processing will strengthen. This, in turn, will influence how we make decisions. Specifically, as these connections strengthen individuals will shift from selecting the more immediate rewards to the longer delayed, but better, rewards. In addition, we expect that the strength of these connections will be related to individual food choices and willingness to exert effort to obtain foods (this was measured using the button press task). Together, this data will help us understand the relationship between brain connectivity, decision-making, and dietary choices across different ages.

When you began the study, you were told that you would receive the food item from the winning bid. However, we left out a few details. Instead of receiving the winning food item, everyone will be given the same amount ($5). This was done to ensure that you would bid according to how much you want the food item. In addition, we are giving everyone $20 for completing the URN task. The reason that we needed to use deception in this study was because we needed participants' behavior and attitudes to be as natural as possible. Thus, we could not give participants complete information before their involvement in the study because it may have influenced their behaviour in a way that would make investigations of the research question invalid. If participants knew the objectives of the study beforehand their behavior and attitudes may have been influenced by this knowledge. In this case, if you knew you weren't receiving the food item this may have influenced how you made the bids.

We hope that you understand the need for deception now that the purpose of the study has been more fully explained to you. We would also like to assure you that most research does not use

deception. Even though this study involved deception, the information given to you about confidentiality, data storage, and security still applies.

Because some elements of the study were different from what was originally explained we have another consent form for you to read and sign.

We really appreciate your participation. This research could not be conducted without the help of participants, and your participation in our study is greatly appreciated! If you have any questions or if you would like more information about the study, please contact Cassandra Lowe (clowe3@uwo.ca) or Dr. J Bruce Morton (bmorton3@uwo.ca).

POST-DEBRIEFING CONSENT FORM

Study Title: Determining the neural basis underlying individual differences in reward-learning and decision-making

Research Investigator:

Dr. J. Bruce Morton

E-mail: bmorton3@uwo.ca

During the debriefing session, I learned that it was necessary for the researchers to disguise the real purpose of this study. I realize that this was necessary since having full information about the actual purpose of the study might have influenced the way in which I responded to the tasks and this would have invalidated the results. Originally, I was advised that I would receive the winning food item from the bidding task. Instead, I received $5 to purchase the item. I have now received a complete verbal and written explanation as to the actual purpose of the study, and have had an opportunity to ask any questions about this and to receive acceptable answers to my questions.

Your signature on this form indicates that the study has been explained to you and all your questions have been answered to your satisfaction. You agree to give permission for the researchers to use my data (or information I provided) in their study. You may withdraw this consent by notifying the researchers of this decision.

_____	_____	_____
Participants' Name (Please Print)	Signature	Date
_____	_____	_____
Name of person obtaining consent	Signature	Date

Appendix E

Compensation Form

Compensation Form for participation in "Determining the neural basis underlying individual differences in reward-learning and decision-making"

By signing below, the signatory acknowledges receiving $45 from the behavioural testing and $30 from the MRI component from the Cognitive Development and Neuroimaging Lab as compensation for your study participation.

Name (printed)	Signature	Date (mm/dd/yyyy)	Amount /MRI or Behavioural Testing
