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Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA,
IRVINE

You're Stressing Me Out:
Adolescent Stress Response to Social Evaluation and its Effect on
Risky Decision-Making

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Psychology and Social Behavior

by

Sachiko Donley

Dissertation Committee:
Professor Elizabeth Cauffman, Ph.D., Chair
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2017

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Table of Contents

List of Figures	iv
List of Tables	v
Acknowledgements	vi
Curriculum Vitae	viii
Abstract of the Dissertation	xiv
I. Research Rationale and Objective	1
The Central Paradox of Adolescent Risk-Taking	1
II. Review of the Literature	5
A Dual Systems Explanation of Adolescent Risk-Taking	5
Stress Response to Social Evaluative Threat During Adolescence	9
Stress Response and Risk-taking During Adolescence	12
Limitations in Prior Works	15
Summary	19
The Current Study	21
III. Research Design and Methods	27
Participant Recruitment Methods	27
Eligibility	29
Sample	31
Procedures	31
Study Measures	39
Plan of Analysis	49
IV. Results	50
Preliminary Analysis of Salivary Data	50
Preliminary Analysis of Self-Report and Behavioral Measures	54
Research Question 1	59
Research Question 2	62
Research Question 3	63
Research Question 4	66
Research Question 5	69
Research Question 6	72
Research Question 7	74
Research Question 8	76
Research Question 9	77
References	93
Appendix A: Institutional Review Board-Approved Documents	113
Appendix B: Funding Sources	127

List of Figures

Figure 1. Detailed Timeline of Study Session	33
Figure 2. Three Evaluators from the Peer-evaluator Trier Social Stress Test Condition	36
Figure 3. Three Evaluators from the Adult-evaluator Trier Social Stress Test Condition	36
Figure 4. The Stoplight Task	42
Figure 5. Observed Cortisol Response to the Trier Social Stress Test by Condition	61
Figure 6. Observed Alpha-Amylase Response to the Trier Social Stress Test by Condition	62
Figure 7. Risky Decision-Making Between TSST Conditions	63
Figure 8. Changes in Self-Consciousness by TSST Conditions	65
Figure 9. Hypothesized mediational effect of self-conscious emotions	72

List of Tables

Table 1. Observed Cortisol and Alpha-amylase by Trier Social Stress Test Condition	52
Table 2. Description of Sample by Trier Social Stress Test Condition	55
Table 3. Correlations among Self-report, Salivary, and Behavioral Data for Full Sample	58
Table 4. Self-Conscious Emotions Regressed on Cortisol Delta Peak Values	67
Table 5. Self-Conscious Emotions Regressed on Cortisol AUC _{Ground}	67
Table 6. Self-Conscious Emotions Regressed on Alpha-Amylase Delta Peak	68
Table 7. Self-Conscious Emotions Regressed on Alpha-Amylase AUC _{Ground}	68
Table 8. Risky Decision-making Regressed on Cortisol Delta Peak	70
Table 9. Risky Decision-making Regressed on Cortisol AUC _{Ground}	70
Table 10. Risky Decision-making Regressed on Alpha-Amylase Delta Peak	71
Table 11. Risky Decision-making Regressed on Alpha-Amylase AUC _{Ground}	71
Table 12. Relation Between Alpha-Amylase Delta Peak and Risky Decision-Making with and without Self-conscious Emotions after TSST	73
Table 13. Risky Decision-Making Regressed on Self-Conscious Emotions After the TSST	74
Table 14. Effect of Trier Social Stress Test condition and Peer Victimization on Self-Conscious Emotions	75
Table 15. Effect of Trier Social Stress Test condition and Resistance to Peer Influence on Self-Conscious Emotions	77
Table 16. Risky Decision-Making Regressed on Interaction Between Cortisol and Alpha-Amylase Delta Peak	79
Table 17. Risky Decision-Making Regressed on Interaction Between Cortisol and Alpha-Amylase AUC _{Ground}	80

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- Fine, A., Cavanagh, C., **Donley, S.V.**, Frick, P.J., Steinberg, L., & Cauffman, E. (in press). Is the effect of justice system attitudes on recidivism stable after youths' first arrest? Race and legal socialization among first-time youth offenders. *Law and Human Behavior*.
- McHugo, G.J., Krassenbaum, S., **Donley, S.V.**, Corrigan, J.D., Bogner, J., & Drake, R.E. (2016). The prevalence of traumatic brain injury among people with co-occurring mental health and substance use. *Journal of Head Trauma Rehabilitation*. Advanced online publication. <http://dx.doi.org/10.1097/HTR.0000000000000249>
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- Kamkwala, A., Norrholm, S.D., Poole, J., Brown, A., **Donley, S.V.**, Duncan, E., Bradley, B., Ressler, K.J., & Jovanovic, T. (2012). Dark-enhanced startle responses and heart-rate variability in a traumatized civilian sample: Putative sex-specific correlates of posttraumatic stress disorder. *Psychosomatic Medicine, 74*, 153-159.
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- Jovanovic, T., Kamkwala, A., **Donley, S.V.,** Poole, J., Sands, L.A., Smith, A., Norrholm, S.D., Ressler, K.J., & Bradley, B. (December, 2010) *Dark-enhanced startle as a biomarker of anxiety is increased in children of abused mothers.* Poster presented at American College of Neuropsychopharmacology. Miami Beach, FL.
- Jacob, M., Smith, C.O., Khoury, L., Karapanou, I., Kamkwala, A., **Donley, S.V.,** & Bradley, B. (November, 2009). *Mental health treatment in low income, African American intergenerational youth trauma victims.* Poster presented at annual meeting for the International Society for Traumatic Stress Studies. Atlanta, GA.
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Abstract of the Dissertation

You're Stressing Me Out:
Adolescent Stress Response to Social Evaluation and its Effect on Risky Decision-Making

By

Sachiko Vanessa Donley

Doctor of Philosophy in Psychology and Social Behavior

University of California, Irvine, 2017

Professor Elizabeth Cauffman, Chair

Compared to children and adults, adolescents make riskier choices and do so more often when in the presence of peers. Traditional cognitive explanations for adolescent behavior have failed to account for increases in risk-taking during this developmental period. More recent biopsychosocial models of adolescent risk-taking have emerged, highlighting the importance of not just cognitive but social and biological factors that contribute to adolescent risk-taking. Nonetheless, one biological system- the adolescent physiological stress system- has been understudied and may add to our understanding of adolescent risk-taking. More specifically, it may be that physiological stress makes adolescents vulnerable to making risky decisions by increasing their self-conscious affective states. These effects were hypothesized to be more pronounced after a stressful encounter with a peer, while being dampened after a stressful encounter with an adult.

Sixty male adolescents aged 12 to 16 were randomly assigned to one of two Trier Social Stress Test (TSST) conditions. In the first condition, adolescents were evaluated by same aged peers, and in the second, adolescents were evaluated by adults. The manipulation of the age of evaluators in these two conditions was effective, with adolescents in the peer condition

perceiving evaluators to be around 17 years old and adolescents in the adult condition perceiving evaluators to be around 31 years old. Throughout the experimental session, adolescents provided 4 whole saliva samples which were assayed for cortisol and alpha-amylase as markers of physiological stress response.

No differences were found between the two TSST conditions regarding physiological stress response and risky decision-making. However, adolescents who were evaluated by adults reported more self-conscious affect compared to adolescents who were evaluated by peers. Additionally, adolescents who were more self-conscious experienced larger changes in salivary alpha-amylase. Although adolescence is a time of social orientation towards peers, the results of the current study illustrate that adults' negative evaluations are powerful and influence adolescents' emotions and physiology. These findings suggest the potential iatrogenic effects of negative adult evaluations in environments like classrooms and juvenile courtrooms.

I. Research Rationale and Objective

The Central Paradox of Adolescent Risk-Taking

Adolescence is a developmental period characterized by increased risk-taking. Compared to adults and children, adolescents are disproportionately more likely to put themselves and others in harm's way (Ozer, Macdonald, Irwin, Mortimer, & Larson, 2002). For example, adolescents are more likely than adults to have unprotected sex, engage in violence, experiment with drugs, and to engage in other criminal behaviors (Blum & Nelson-Mmari, 2004; Hirschi & Gottfredson, 1983; Shulman, Steinberg, & Piquero, 2013; Williams, Holmbeck, & Greenley, 2002). A report from the Centers of Disease Control and Prevention revealed that 41.4% of a national sample of adolescents reported texting or emailing while driving. In terms of substance use, 34.9% had drunk alcohol and 23.4% had used marijuana. During the 12 months before the survey, 8.0% had attempted suicide (Kann et al., 2014). Considering these reports, it is not surprising that the leading causes of mortality for adolescents are motor vehicle crashes (23%), other unintentional injuries (18%), homicide (15%), and suicide (15%), exemplifying the enormous personal and societal costs of adolescent risky decision-making (Kochanek, Murphy, Xu, & Arias, 2014).

Why is adolescence a developmental period marked by disproportionately high levels of risk-taking behavior? The overarching goal of this study is to offer a biopsychosocial explanation to this question. Earlier work on adolescent risk-taking was primarily focused on the cognitive aspects of risky decision-making. More current scholars have shown, however, that focusing only on the cognitive aspects of risky decision-making completely neglects two factors that promote risky behavior--the social contexts in which adolescent risky behaviors take place as

well as the biological factors that make adolescents different from adults. In this vein, the proposed study uses a novel method to test whether stressful social contexts and adolescents' physiological responses to these contexts can help explain their risky decisions.

Risk-taking inherently involves a decision between two or more choices that have uncertain positive or negative outcomes. For example, an adolescent may be faced with the decision to get in the car with a drunk driver. Using a more cognitive framework to address this risky dilemma, the adolescent must understand the choices at hand (to get in the car or to pass on the ride), comprehend the potential negative and positive outcomes of each choice (risk being in a car crash but getting home on time), and make a reasoned decision (choose to not get into the car and to notify a parent of breaking curfew). The cognitive tasks described- appraisal of choices, comprehension of the relative costs and benefits of each choice, followed by a reasoned decision were the focus of early scholars in the field of adolescent risk-taking (Furby & Beyth-Marom, 1992). The overarching hypothesis of this early work was that the high prevalence of risk-taking during adolescence was due to adolescents' lack of cognitive skills to make reasoned, risk-averse decisions. In other words, adolescents are not yet smart enough to make the right choice in a risky dilemma. However, very little empirical work has supported this hypothesis, and the purely cognitive explanation of adolescent risk-taking has largely failed to explain why adolescents take more risks than children or adults (Beyth-Marom, Austin, Fischhoff, Palmgren, & Jacobs-Quadrel, 1993; Reyna & Farley, 2006). The reason being that adolescents have proven to be fully capable of the cognitive tasks involved in making good choices (Keating, Lerner, & Steinberg, 2004).

Several hallmark studies have illustrated adolescents' ability to understand risks, understand the consequences of risk, and to make reasonable, risk-averse decisions. According to

a purely cognitive explanation of adolescent risky decision-making, adolescents would be expected to underestimate their chances of encountering negative life experiences, thinking they were immune to the negative outcomes of their actions. Other researchers, however, found the opposite (Fischhoff et al., 2000). For example, a national sample of adolescents' was asked to estimate how at risk they were to experience 18 specific life events (e.g. arrest, death, victim of a crime). Compared to public health statistics, adolescents overestimated the likelihood of being arrested, dying at a young age, and being a victim of a crime. Additionally, adolescents' reports of the probability of experiencing other life events, such as dropping out of school, were highly accurate compared to national statistics. Overall, adolescent estimates of the likelihood of various events occurring were quite accurate, but when inaccurate, adolescents tended to overestimate, not underestimate, their risk. This finding has been replicated numerous times (Millstein & Halpern-Felsher, 2002) and illustrates that adolescents are not unable to recognize their risk of encountering negative life events.

Not only have adolescents been shown to overestimate how at risk they may be to experience specific life events, they are also just as competent as adults in understanding the consequences of risky behaviors. In one study (Beyth-Marom et al., 1993), researchers gave adolescent and adult participants a series of hypothetical risky scenarios (e.g. drink and drive, smoking marijuana, taking another person's car). They then asked participants to list possible consequences of either engaging in the risky behavior or avoiding the risky behavior. Responses of adolescents and adults were similar, indicating no significant differences between adolescents' and adults' comprehension of possible consequences of risky behaviors. Further, for several of the hypothetical risky scenarios presented, adolescents were actually able to list more negative consequences than adults.

A final illustration that adolescent risk-taking cannot be explained solely through cognitive factors is the remarkably low success rates of education-based health programs (e.g. D.A.R.E., abstinence education, driver training) in preventing youth from engaging in risky behaviors. If risky behavior were driven by adolescents' lack of understanding the consequences of unprotected sex, drug use and other health-risk behaviors, then we would expect that offering adolescents more education would result in significant reductions of risky behaviors. However, empirical work illustrates that education-based programs are more effective at changing adolescents' knowledge than they are at bettering their chances of making good decisions in risky, real-life dilemmas (Ennett, Tobler, Ringwalt, & Flewelling, 1994; Graham & Gootman, 2008; Trenholm et al., 2007). Simply educating adolescents' about risks and their consequences do not make them less prone to make risky decisions in real-life contexts.

In sum, research has shown that adolescents are just as able as adults to assess risks as well as understand and weigh the consequences of risks. Thus, there is little empirical evidence to support that adolescents' greater involvement in risk-taking is solely due to cognitive deficits or their inability to learn of the consequences of taking risks. And therein lies the central paradox of adolescent risk-taking: if adolescents have the cognitive abilities to understand and evaluate risks and their consequences, then why are they so prone to taking risks? In other words, if adolescents are so smart, then why do they make such stupid, risky decisions? Several lines of research have made advancements towards solving this paradox. Mainly, relevant research has focused on the importance of social contexts during adolescence as well as biological factors that are unique to adolescents.

The current dissertation's goal is to further efforts to resolve the paradox of adolescent risk-taking. The proposed study takes a biopsychosocial approach that considers several social

and biological factors that have been understudied in this area of research. My hypotheses expand on the dual systems theory of adolescent risk-taking, which posits that in social and highly emotional contexts, adolescent decision-making operates differently than in non-social, unemotional contexts (such as in much of the early work on adolescent cognition). This discrepancy has been largely attributed to brain development that continues into young adulthood. However, I make the argument that another biological system- the physiological stress system- should also be considered in this puzzle of adolescent risk-taking. To this end, the main objective of the proposed study is to use an experimental paradigm to investigate how adolescents' physiological and emotional response to a stressful social situation influences subsequent risky decision-making.

II. Review of the Literature

A Dual Systems Explanation of Adolescent Risk-Taking

Dual systems theory (Steinberg, 2010) addresses some of the shortcomings of previous research that focused exclusively on the cognitive factors of adolescent risk-taking. The theory posits that there are two, not one, systems involved in risky decision-making. The first system is the cognitive control system, which is largely responsible for the cognitive tasks that are involved in risky decision-making described previously (appraisal of choices, comprehension of the relative costs and benefits of each choice, capacity to make reasoned decision). However, in real-life scenarios, the cognitive control system does not work in isolation. The second system, referred to as the socio-emotional system, is also at play. The socio-emotional system is an affective neural system that is activated during adolescence, thus making adolescents more inclined towards social experiences and more easily aroused by emotional and social stimuli

(Nelson, Leibenluft, McClure, & Pine, 2005). Considering both of these systems, as opposed to just the cognitive control system, helps explain why adolescents engage in risky behavior despite knowing better.

According to the dual systems theory of adolescent risk-taking, adolescents' socio-emotional and cognitive control systems develop on different timelines. The socio-emotional system develops more rapidly. Meanwhile, the cognitive-control system develops more gradually (Steinberg, 2010). Steinberg and colleagues illustrated this phenomenon using a cross-sectional study design with 935 individuals aged 10 to 30 (Steinberg et al., 2008). They found that the socio-emotional system followed a curvilinear pattern across age such that adolescents exhibited the most active socio-emotional systems and were most likely to seek out stimulating, social experiences. Conversely, the cognitive control system developed linearly across age into adulthood, suggesting that the oldest individuals in the sample were the best equipped to exercise cognitive control.

Because development of the cognitive control and socio-emotional systems occurs asynchronously, adolescents' socio-emotional system may override their still-developing cognitive control system in real-world contexts. If we return to the example of the adolescent making a decision to get in the car with a drunk driver, dual systems theory would suggest that due to the social and emotional forces at play, the adolescents' cognitive control system may not be able to inhibit the adolescent from getting in the car. As the cognitive control system matures, however, it becomes more capable of blocking impulses from the socio-emotional system (Knoch & Fehr, 2007), leaving individuals better equipped to make good decisions in the face of emotionally-distracting, social stimuli. This capacity for self-control continues to develop beyond adolescence. Thus, much of adolescents' engagement in risk-taking can be attributed to

their heightened proclivity for social and emotional experiences during a time in which self-control is still immature (Steinberg, 2010).

Dual systems theory and the empirical work to support the theory illustrates why adolescents may make poor decisions in real-world contexts despite knowing better. As described in the previous section, cognitively, adolescents understand risks and the consequences of them. Adolescents' cognitive abilities largely match those of adults in situations that are not social and non-emotional (reflective of "cold" cognitive processes), and they are capable of mature decision-making in such contexts (Figner, Mackinlay, Wilkening, & Weber, 2009; Kuhn, 2009). However, in situations that elicit "hot" cognition (such as social contexts that evoke an affective response), adolescents perform more poorly than adults (Figner et al., 2009). For example, in a cognitive-based impulse control task (the Go/No Go) using rewarding social cues (happy faces), adolescents exhibited reduced performance compared with children and adults in their ability to control their impulses in the presence of socially rewarding cues (Somerville, Hare, & Casey, 2011). Thus, while adolescents may be developmentally capable of enacting mature cognitive control, their cognitive control systems may become "high-jacked" by the presence of emotional and social stimuli. This can become problematic in real-world risky dilemmas, which tend to take place in social situations involving emotional stimuli. Further, it illustrates the importance of considering the social contexts and the emotional experiences that leave adolescents vulnerable to risk-taking.

The dual systems theory of adolescent risk-taking has largely focused on brain development to explain the temporal gap between adolescents' socio-emotional and cognitive control systems. During puberty, it is thought that gonadal hormones affect the activity of oxytocin in socio-emotional brain regions, specifically the amygdala and the nucleus

accumbens (Nelson et al., 2005). Oxytocin plays a crucial role in social bonding and regulates the recognition of social stimuli (Insel & Fernald, 2004). This change in the activity of oxytocin in the socio-emotional system of the brain is thought to make adolescents respond differently to social stimuli, affecting their subsequent emotional and behavioral responses. Social experiences may simply feel better to adolescents compared to adults, thus making their decision-making more vulnerable to less-than optimal choices. As authors in the book, “The Teenage Brain” eloquently summarize, unlike adults, “the chief predictor of adolescent behavior is not the perception of risk, but the anticipation of the reward *despite* the risk” (Jensen & Nutt, 2014, page 107). At the same time, due to a still developing prefrontal cortex (Hooper, Luciana, Conklin, & Yarger, 2004), adolescents do not yet have the cognitive abilities to regulate their emotions through appraisal and reappraisal strategies and to inhibit impulsive behaviors (Blakemore & Choudhury, 2006). Adolescent brain development provides one explanation for why adolescents are more emotionally reactive to social stimuli and do not possess the skills to regulate or control their emotional reactions, thus leaving them more vulnerable to make poor decisions in risky dilemmas. In sum, research has illustrated that brain development is unique during adolescence-adolescent brains are unlike those of children and adults, which helps to explain the disproportionately high risk-taking that is observed during adolescence.

Adolescent brain development is a critical piece in the puzzle of adolescent risk-taking. However, the role of other biological systems need also be considered to understand how they contribute to or help explain adolescent risk-taking. In the next sections of this proposal, I argue that the physiological stress response system is a logical next candidate and is understudied in a dual systems of adolescent risk-taking framework.

Stress Response to Social Evaluative Threat During Adolescence

In many ways, adolescence is a stressful developmental period. New, stressful challenges arise during adolescence in practically all domains of life including familial (Johnson, Lavoie, & Mahoney, 2001), academic (Roeser, Eccles, & Sameroff, 2000), romantic relationships (La Greca & Harrison, 2005), and peer networks (Smetana, Campione-Barr, & Metzger, 2006). Although these stressors are largely normative, adolescents report feeling stressed more frequently than children and adults (Hampel & Petermann, 2006). In other words, adolescents get stressed out by the normative challenges they face (Seiffge-Krenke, 2013). Not only do adolescents perceive their lives as stressful, but there is emerging, good evidence that adolescence is a time of heightened physiological stress response- compared to children and adults, adolescents appear to react (physiologically) more strongly to stressors (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009).

Stress triggers a coordinated set of physiological and psychological responses (Weiner, 1992). One system involved in the psychobiology of stress is the hypothalamic-pituitary-adrenal (HPA) axis. When stressed, the hypothalamus releases a hormone called corticotrophin-releasing hormone (CRH). CRH triggers another part of the brain- the pituitary gland, which releases adrenocorticotrophic hormone (ACTH). Finally, ACTH triggers the adrenal glands, which release cortisol. Levels of cortisol are monitored by the hypothalamus such that increased levels result in a reduction of CRH release and decreased levels of cortisol result in an increase of CRH release. Thus, the coordination of the HPA axis both helps the body prepare for and regulate stress.

The hypothalamic-pituitary-adrenal (HPA) axis is particularly sensitive to a specific kind of stressor- social evaluative threat. Social evaluative threat occurs when an important aspect of self-identity is, or might be, negatively judged by others (Dickerson & Kemeny, 2004). There is

an abundance of evidence that illustrates that when adults are evaluated negatively and an important aspect of their identity (e.g. intelligence, competence), is negatively judged, their HPA axis is activated and their levels of cortisol (a marker of HPA activity) increase (Dickerson & Kemeny, 2004). The Trier Social Stress Test (TSST) is a widely accepted experimental paradigm that was developed to induce and study the psychobiology of stress. During the TSST, participants are asked to engage in a performance task (e.g. give a speech about a historical figure, answer challenging math questions) in front of a small panel of evaluators. The evaluators are research assistants who are trained to give negative social evaluative cues to the participant. For example, evaluators do not smile or nod or confirm satisfactory performance. Rather, while taking notes, they verbally correct the participant's errors. It is believed that this paradigm is one of the most successful in inducing a physiological stress response due to its element of social evaluative threat- the experience of being negatively judged while performing is very stressful (Dickerson & Kemeny, 2004). Importantly, what appears to make the TSST stressful is this element of social evaluative threat. One study illustrated that just the mere presence of evaluators did not induce significant changes in HPA activity while negative evaluation resulting in social evaluative threat did (Dickerson, Mycek, & Zaldivar, 2008).

There is good evidence of adolescents' heightened physiological stress response to social evaluative threat. Gunnar and colleagues administered the Trier Social Stress Test (TSST) to a sample of eighty-two 9 to 15 year olds (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009). Salivary cortisol was used as a marker of stress responsivity to the TSST. Developmental effects were observed for cortisol, such that 15 year olds responded more strongly than 11 year olds to the TSST, suggesting that older participants were more stressed by the TSST compared to younger participants. Stroud and colleagues found similar results using the TSST with a group of

children aged 7 to 12 years and adolescents aged 13 to 17 years (Stroud et al., 2009). Higher levels of cortisol were observed among the older youth compared to the younger participants. Finally, Sumter and colleagues used the Leiden Public Speaking Task with 294 nine to 17-year olds (Sumter, Bokhorst, Miers, Van Pelt, & Westenberg, 2010; Westenberg et al., 2009). Similar to the TSST, the Leiden Public Speaking Task induces social evaluative threat by having participants give a speech in front of a video-tapped classroom of unengaged peers. In terms of stress response to the task, 13 to 14 year olds exhibited the strongest cortisol responses compared to all other age groups.

Adolescents' heightened physiological stress response is not believed to be specific to social evaluative threat per se. For example, adolescents' basal levels of cortisol- their levels of cortisol output in the absence of an acute stressor- also appear elevated compared to children and adults (Adam, Klimes-Dougan, & Gunnar, 2007). Additionally, adolescents have been found to respond more strongly than children to stressors involving peer rejection (Stroud et al., 2009). This suggests that adolescents' hypothalamic-pituitary-adrenal (HPA) axis is both more active in non-stressful contexts and more easily activated by stressful contexts, and this is likely due to pubertal changes (Gunnar et al., 2009).

However, in relation to adolescent risk-taking, particularly in a dual systems framework, it is important to consider social forces at play. And thus, the literature on adolescents' physiological stress to social evaluative threat is particularly relevant because it is likely that adolescent social interactions that involve risky dilemmas also involve social evaluative threat. For example, if two adolescents are discussing whether or not to shoplift a candy bar, one adolescent may feel that the other will judge him based on his decision to engage in theft or not. If he does engage in theft, perhaps his peer will think he is immoral. If he does not engage in

theft, perhaps his peer will think he is a coward. Both morality and braveness may be important aspects of the adolescents' identity and thus he may feel threatened and stressed by the social evaluation he is experiencing. But what are the consequences of this stress on adolescent risky decision-making?

Stress Response and Risk-taking During Adolescence

There is reason to believe that adolescent stress, specifically to social stressors, compromises the cognitive control system, thus leaving adolescents more likely to make poor decisions in stressful social contexts. If this were the case, we would expect to see a positive relation between adolescent stress response and risky decision-making. Although surprisingly little work has examined the relation between adolescent stress response to acute social stressors and adolescent risk-taking (Galván & Rahdar, 2013; Starcke & Brand, 2012), two important conclusions can be cautiously derived from previous work. First, the studies that report a positive association between stress response and risk-taking examine stress response to *social* stressors. Social stressors are defined as stressful events where at least one other person is contributing to the experience of stress (Dickerson et al., 2008). Social evaluative threat is one such social stressor and is used in a couple of the studies that illustrate a positive relation between stress and adolescent risk-taking. Conversely, past studies that report a negative association between stress response and risk-taking typically use *non-social* stressors (e.g. a stressful riddle or puzzle that is completed alone). This pattern is in line with the dual systems theory as it suggests that adolescents' stress response to social and non-social stressors may relate differently to adolescent risk-taking behaviors. The second conclusion that can be cautiously drawn from this work is the importance of moderators in the relation between adolescent stress response and adolescent risk-

taking. Specifically, adolescents' baseline proclivity towards risk-taking and adolescents' emotional states are important to consider in said relation.

Johnson, Dariotis and Wang found that adolescents under stress make more risky decisions (Johnson, Dariotis, & Wang, 2012). In their research, eighty-nine adolescents completed a computerized risk-taking task. Adolescents were randomly assigned to one of two conditions- a control condition during which adolescents completed a risk-taking task in a neutral state, or a stressor condition in which adolescents completed the same risk-taking task but after completing the Trier Social Stress Test. Results indicate that adolescents in the stressor condition took more risks compared to those in the control condition. However, differences in risk-taking under stress were directly related to risk-taking tendencies at baseline such that adolescents who had a proclivity towards risk-taking were prone to taking more risks in the stressor condition, illustrating that proclivity towards risk-taking is associated with risk-taking under stress.

Reynolds and colleagues also identified that adolescents under stress engage in riskier decision-making (Reynolds et al., 2013). Thirty-four adolescent participants were grouped into low and high social anxiety groups based on self-reported experiences with social anxiety. Within each group, adolescents were randomly assigned to one of two conditions- a stressor condition that involved the Trier Social Stress Test, and a control condition that involved no social stressor. Adolescents with high social anxiety exhibited greater risk-taking when exposed in the stressor condition. Among adolescents with low social anxiety, however, there were no differences in risk-taking between the stressor and control groups. This suggests that emotional states, specifically social anxiety in this case, are likely related to increased adolescent risk-taking in stressful contexts.

A final study used a quasi-naturalistic design to illustrate a positive association between stress and adolescent risk-taking. Galvan and McGlennen provided preliminary data among a sample of 18 adolescents aged 14 to 17 (Galván & McGlennen, 2012). Using daily diary methods, adolescents self-reported on their levels of stress throughout the day. When reporting on the types of daily stressors experienced, adolescents were most likely to report stressors that were social in nature (e.g. fights with parents or friends). Adolescents were also asked to come to the laboratory during high stress and low stress days. On high stress days, participating adolescents were more likely to make risky decisions on a computerized risky decision-making task. This preliminary work suggests that social stressors outside of the laboratory may increase risk-taking among adolescents.

In sum, there is some evidence of a positive association between acute stress response and risk-taking among adolescents. Importantly, however, all of these prior studies use social stressors (the Trier Social Stress Test and natural daily social stressors). Additionally, this work points to the important moderating effects of baseline proclivity towards risk-taking behaviors as well as social anxiety.

Although there is emerging evidence that adolescents under stress take more risks, there is also evidence that adolescents under stress take fewer risks. Daughters and colleagues found that cortisol output following a non-social laboratory stressor, the BIRD task, was negatively associated with risk taking for male adolescents (Daughters, Gorke, & Matusiewicz, 2013). Males with a smaller area under the curve and peak cortisol output took more risks during the study's computerized risk-taking paradigm. There was no association between salivary cortisol and risk-taking among female adolescents. This study not only provides opposing evidence, but also points to a potentially important moderator—gender. Several additional studies using

samples of adults have illustrated that the relation between physiological stress response and risk-taking is positive among men, but negative among women. In other words, when stressed, men take more risks while women take fewer risks (Lighthall, Mather & Gorlick, 2009; Van den Bos, Harteveld & Stoop, 2009). Further, male adolescents engage in more risk-taking than females (Byrnes, Miller & Schafer, 1999), and these studies suggest that this may be due to gender-specific differences in physiological responses to stress. In a second, naturalistic study, Ouimet and colleagues provide additional evidence that smaller cortisol-responses are related to more risky decisions; adolescents with a smaller cortisol response to a non-social math stressor had more driving accidents and near-accidents over an 18-month period (Ouimet, Brown, Guo, & Klauer, 2014).

Previous work suggests that adolescent decision-making is different when it takes place in stressful social compared to stressful non-social contexts. For this reason, it provides some support for a dual systems theory of adolescent risk-taking and the integration of the psychobiology of stress in a dual systems framework. The positive association between stress response and adolescent risky decision-making in previous work may suggest that adolescent stress, specifically to social stressors, compromises the cognitive control system, thus leaving adolescents more likely to make poor decisions in stressful social contexts. Nonetheless, additional work in this area is necessary and questions remain regarding the consistency of this finding and more importantly, the mechanisms that explain this relation and additional factors that moderate this relation.

Limitations in Prior Works

One major limitation in the current literature is the difficulty in disentangling which component of the psychobiology of stress is contributing to adolescent risk-taking. The

psychobiology of stress is an intricate and coordinated process that involves multiple biological systems and multiple psychological processes. In the literature on adolescent risk-taking and stress response, the sympathetic nervous system (SNS) is commonly overlooked. While cortisol is a marker of activity of the hypothalamic-pituitary-adrenal axis (HPA), salivary alpha amylase (sAA) is a marker of SNS response. Importantly, the SNS and the HPA are independent but coordinated systems that serve different purposes. HPA axis activity is a passive response to novel or unpredictable stressors that are perceived as uncontrollable (such as the inability to control other people's judgments in social evaluative contexts). Sympathetic nervous system response is more fast-acting and is thought to drive action in stressful context- sAA is released at times when the body is thought to need more energy (Granger, 2007). There is emerging evidence of the importance of accounting for SNS activity and its possible additive, interactive, or deductive effects on HPA activity. For example, there is evidence that accounting for both SNS and HPA activity may predict problem behaviors better than assessing the activity of one system alone (Allwood, Handwerker, Kivlighan, Granger, & Stroud, 2011; Bauer, Quas, & Boyce, 2002; El-Sheikh, Erath, Buckhalt, Granger, & Mize, 2008; Gordis, Granger, Susman, & Trickett, 2008; Susman et al., 2010).

In the current literature on adolescent risk-taking and its relation to stress, when salivary markers of stress are considered, there has been sole focus on cortisol. To date, salivary alpha-amylase (sAA) as a marker of sympathetic nervous system (SNS) activity has yet to be examined in relation to adolescent risk-taking. However, both HPA activity and SNS activity are likely involved in risky decision-making in social contexts. While the HPA axis is activated by social evaluative threat, the SNS is also activated by social evaluative threat and by social exclusion (Stroud et al., 2009) as well as negative emotionality (Byrd-Craven, Granger, & Auer, 2011).

Considering adolescents have difficulty making decisions in social contexts with emotional stimuli, it is possible that adolescents who exhibit high HPA activity and high SNS activity will be at most risk for making risky decisions.

A second major limitation of previous work in this area is the lack of information on whether adolescents' stress response may be stronger to social evaluation from same-aged peers compared to adult evaluators. Adolescence is a developmental period that is characterized by social orientation towards peers (McElhaney, Allen, Stephenson, & Hare, 2009; Nelson et al., 2005). Adolescents reference their peers to come to social and sometimes moral decisions (Bednar & Fisher, 2003), they adopt their peers' mannerisms and language to develop a peer group "culture" (Eccles, Barber, Stone, & Hunt, 2003; Eckert, 2003), they adopt their peers' negative health behaviors such as substance use (Monahan, Rhew, Hawkins, & Brown, 2014), and adolescents appear to become more aware of their peers' opinions about them (Vartanian, 2000). Altogether, adolescents develop autonomy from parental and adult figures and begin to build an identity that is highly influenced by peers (Sebastian, Viding, Williams, & Blakemore, 2010; Smetana et al., 2006). Even during unstructured leisure time adolescents prefer and will attempt to spend time with their peers instead of adults such as family members (Brown & Larson, 2009). Additionally, adolescents rate peer interactions (as opposed to interactions with adults such as parents or teachers) to be their most rewarding experiences (Larson, Csikszentmihalyi, & Graef, 2014). Finally, these self-reports are supported by neuroimaging studies showing that the presence of peers activates reward-related brain circuits (Chein et al., 2011). Together, this suggests interactions with peers is more socially rewarding for adolescents than interactions with non-adolescents. This would in turn suggest that for adolescents, peers and not people of other age groups, increase the salience of social rewards and thus promote riskier

decisions. If this were the case, we would then expect that being in the presence of an individual from a different age group (such as an adult) could have differential effects on adolescent risky decision-making and possibly deter it. However, empirical evidence is required to make these conclusions; considering adolescence is a time of orientation towards peers, the question remains as to whether sensitivity to social evaluative threat is exacerbated even further if evaluation is from a similarly-aged adolescent.

Additionally, in the literature on adolescent stress response and risky decision-making, there is lack of focus on social experiences and individual factors that may protect or exacerbate adolescents' vulnerability to social evaluation from peers and subsequent risk-taking. For example, overt and relational victimization is positively associated with social anxiety and fear of negative evaluation (La Greca & Lopez, 1998; Storch, Brassard, & Masia-Warner, 2003; Storch & Masia-Warner, 2004). As such it is likely that adolescents' experiences with their peers (both positive and negative) will influence how they respond to social evaluation from them. Indeed, research has illustrated that physiological stress response may make youths more susceptible to the negative health effects of peer victimization (Rudolph, Troop-Gordon, & Granger, 2011). Therefore it is important to understand how youths who have been victimized by peers respond to social evaluation from them and how this may affect their susceptibility to make poor decisions. While peer victimization may be a vulnerability factor that makes adolescents more sensitive to social evaluation, resistance to peer influence may act as a buffer. Resistance to peer influence refers to adolescents' ability to act and think autonomously from their peers. Adolescents who have more resistance to peer influence may thus not care as much about negative evaluations from peers and may therefore be less affected by peer-based social evaluative threat.

Finally, the literature on adolescent stress response and risky decision-making has yet to account for the role of emotions in this relation, specifically self-conscious emotions (Dahl & Gunnar, 2009; Sebastian, Burnett, & Blakemore, 2008). Self-conscious emotions, such as shame and guilt, are emotions that heighten awareness of negative aspects of oneself. Empirical work has shown that compared to children and adults, adolescents care more about what other people think of them, adolescents become more aware of others' opinions about them, and adolescents' emotional health is deeply rooted in being accepted by others (Kingery, Erdley, & Marshall, 2011; Sebastian et al., 2008; Vartanian, 2000).

In the adult literature, it has been documented that self-conscious emotions are positively related to physiological markers of stress following laboratory stressors involving social evaluative threat (Dickerson, Gruenewald, & Kemeny, 2004; Dickerson, 2008; Gruenewald, Kemeny, & Aziz, 2006). Considering adolescence is a development period where feelings of self-consciousness peak (Rankin, Lane, Gibbons, & Gerrard, 2004; Rosenblum & Lewis, 2003), it is important to understand if this is a factor that results in heightened stress response to social evaluation. Further, as discussed earlier, it is well documented that adolescents have difficulty making sound decisions in highly emotional states (Steinberg, 2005). It is therefore important to know whether adolescents are more vulnerable to react emotionally to social evaluative threat, whether their inability to regulate self-conscious emotions is related to increased physiological response, and if this helps explain why adolescents may be vulnerable to making poor decisions in highly social and emotional contexts.

Summary

Identifying biological factors that are unique during adolescence has helped explain adolescents' disproportionately high levels of risk-taking behaviors. Specifically, adolescent

brain development has been shown to put adolescents at risk of making poor decisions in the face of social and emotional stimuli (Blakemore & Choudhury, 2006). Emerging work shows that the physiological stress response system may also be unique during adolescence. Compared to children and adults, adolescents appear to be more sensitive to stressors, exhibiting heightened physiological reactivity to them (Gunnar, Wewerka, et al., 2009; Stroud et al., 2009; Sumter et al., 2010). As such, research suggests that adolescence may be a developmental period of physiological sensitivity to stressful social contexts- adolescents may be more perturbed by stressors, particularly ones that are social and evaluative in nature. This is consistent with adolescents' reports of feeling more stressed than children and adults (Hampel & Petermann, 2006).

The consequences of adolescents' heightened physiological stress reactivity on their risk-taking behaviors is surprisingly understudied. However, the work that does exist suggests that the integration of the psychobiology of stress in a dual systems of adolescent risk-taking framework is promising. Specifically, there is reason to believe that adolescent stress to social evaluative threat compromises the cognitive control system, leaving adolescents more likely to make poor decisions in stressful social contexts (Galván & McGlennen, 2012; Johnson et al., 2012; Reynolds et al., 2013).

However, several gaps in the literature on the relation between adolescent stress response and risky decision-making need to be addressed. First, it is important to move away from singular markers of stress response and to take a multisystem approach. Specifically, research has thus far mostly used cortisol as a marker of adolescent hypothalamus-pituitary-adrenal axis response. However, the sympathetic nervous system is activated by negative social experiences and negative emotional experiences. As adolescents have difficulty making decisions in highly

emotional social contexts, the role of sympathetic nervous system activity on adolescent risky decision-making should be considered. Second, considering adolescence is a developmental period where judgments and opinions of peers shape self-identity (Brown & Larson, 2009), it is important to know whether adolescents will respond more strongly to stressful negative evaluation from peers compared to adults. Finally, the role of self-consciousness in the relation between stress response and adolescent risk-taking needs to be examined considering adolescence is a time when self-consciousness peaks and difficulty regulating emotions has been linked to poor decision-making.

In sum, integration of the psychobiology of stress in a dual systems theory of adolescent risk-taking is promising. By doing so, it would be posited that due to activation of the socio-emotional neural systems in the adolescent brain, adolescents are more sensitive to social evaluation and are more vulnerable to experience self-conscious emotional reactions to social evaluation. Due to the still-developing brain systems responsible for cognitive control, adolescents will have more difficulty regulating these self-conscious emotions, especially when stressed. Thus, stressful social contexts that involve negative social evaluation will make adolescents more susceptible to making risky decisions.

The Current Study

The current study has four overarching goals. The first goal of the proposed study is to examine whether adolescents' stress response (as measured by salivary cortisol and alpha amylase) is related to subsequent risk-taking. The second goal of the proposed study is to examine whether adolescents' stress responses are exaggerated if they are negatively evaluated by same-aged peers. Additionally, the proposed study will address a potential mechanism- difficulty regulating self-conscious emotions- that may explain a relation between stress response

and poor decision-making. Finally, the proposed work will look at history of peer victimization and resistance to peer influence as they relate to feelings of self-conscious emotions and physiological stress response.

To address these goals, this dissertation will focus solely on male adolescents. While understanding the stress response and risky behaviors of girls is important, the limitations of data collection preclude collecting a full sample of adolescents. Since males are more likely to engage in risk taking behavior than females (Byrnes, Miller, & Schafer, 1999; Fergusson & Horwood, 2002; Moffitt & Caspi, 2001), males and females response to social situations has been found to be different with males engaging in riskier decisions under stress (Daughters, Gorka, Matusiewicz, & Anderson, 2013; Lighthall, Mather & Gorlick, 2009; Lighthall et al., 2012; Van den Bos, Hartevelde & Stoop, 2009), and the hormonal changes of the menstrual cycle impact on the understanding of stress hormones (Kirschbaum, Kudielka, Gaab, Schommer & Hellhammer, 1999), it was decided that the first step to understanding stress and risky decision making within a social context should be conducted among males.

Research Questions and Hypotheses

Research Question 1. *Do adolescents experience more social stress (as measured by salivary cortisol and alpha amylase) when being negatively evaluated by same-aged peers compared to when being negatively evaluated by adults?*

Hypothesis 1. Adolescents who receive social evaluation from same-aged peers will exhibit a stronger physiological stress response compared to adolescents who receive social evaluation from adults. More specifically, adolescents in the peer-evaluator condition of the Trier Social Stress Test (TSST) will experience a stronger physiological stress response compared to adolescents in the adult-evaluator condition of the TSST. Adolescence is a

developmental period when sensitivity to peer influence peaks (Steinberg & Monahan, 2007) and autonomy from adult figures develops (McElhaney, Allen, Stephenson & Hare, 2009). Further, previous research has suggested that compared to children, adolescents exhibit a stronger physiological stress response (saliva alpha amylase) to peer-based rejection tasks than performance-based tasks involving adult evaluators (Stroud et al., 2009). As such, it is hypothesized that adolescent participants in the peer-evaluator condition of the TSST will experience a stronger physiological stress response than those in the adult-evaluator condition

Research Question 2. After a stressful situation with same-aged peers, do adolescents take more risks compared to after a stressful situation with adults?

Hypothesis 2. Adolescents who are evaluated by peers will be prone to make more subsequent risky decisions compared to adolescents who are evaluated by adults. More specifically, adolescents in the peer-evaluator condition of the Trier Social Stress Test (TSST) will exhibit more subsequent risk-taking behaviors compared to adolescents in the adult-evaluator condition of the TSST. As adolescence is a time of sensitivity to peers (Brown & Larson, 2009), it is believed that adolescents who experience social evaluative threat from same-aged peers will be more prone to making poor decisions compared to adolescents who experience social evaluative threat from adults.

Research Question 3. Do adolescents feel more self-conscious when being negatively evaluated by same-aged peers compared to when being negatively evaluated by adults?

Hypothesis 3. Adolescents who receive social evaluation from adolescents will have more difficulty regulating their self-conscious emotions compared to adolescents who receive social evaluation from adults. More specifically, adolescents in the peer-evaluator condition of the Trier Social Stress Test (TSST) will experience more self-conscious emotions compared to

adolescents in the adult-evaluator condition of the TSST. Adolescence is a development period when self-identity develops through peer interactions (Sebastian, Burnett & Blakemore, 2008). As such it is believed that adolescents will care more about novel peer experiences (i.e. adolescent evaluators' judgments in the TSST) compared to novel adult experiences (i.e. adult evaluators' judgments in the TSST).

Research Question 4. *Do adolescents who feel more self-conscious when being negatively evaluated also exhibit stronger stress responses compared to adolescents who feel less self-conscious?*

Hypothesis 4. Adolescents who experience stronger self-conscious emotions will be more likely to experience stronger physiological stress responses. The differential stress response described in hypothesis 1 will be related to adolescents' ability to regulate their self-conscious emotions (hypothesis 3). Specifically, adolescents in the peer-evaluator condition of the Trier Social Stress Test (TSST) will have more difficulty regulating their self-conscious emotions compared to adolescents in the adult condition of the TSST. Similarly, adolescents in the peer-evaluator condition of the TSST will exhibit a stronger stress response compared to adolescents in the adult condition of the TSST. Further, individual physiological stress response will be positively related to self-conscious emotions experienced following the TSST. This relation has been found formerly using an adult sample (Dickerson, Gruenewald & Kemeny, 2004). It is likely that this relation will be identifiable using a sample of adolescents as adolescence is a developmental period of heightened self-consciousness (Nelson et al., 2005). In addition, there is evidence that this relation will be even more pronounced during adolescence due to adolescents' sensitivity to social evaluative threat (Sumter, Bokhorst, Miers, Van Pelt & Westenberg, 2010).

Research Question 5. *Is social stress (as measured by salivary cortisol and alpha amylase) related to subsequent risky decision-making among adolescents?*

Hypothesis 5. Adolescents who exhibit stronger physiological stress responses (regardless of TSST condition) will be more likely to exhibit greater risky decision-making. Based on the dual systems theory of adolescent risk-taking, it is hypothesized that adolescents who exhibit a stronger physiological stress response will also be more prone to making risky decisions. In line with the Theory, it is believed that adolescents who are more sensitive to social stimuli and have more difficulty regulating their emotions in social situations will also have more difficulty making sound decisions.

Research Question 6. *Do adolescents' self-conscious emotions help explain the relation between their physiological stress response and their risky decision-making?*

Hypothesis 6. Adolescents' self-conscious emotions will be a pathway that explains the relation between physiological stress response and risky decision-making. In line with the dual systems theory of adolescent risk-taking, it is hypothesized that adolescents' ability to regulate their self-conscious emotions will explain (at least partially) the relation between their stress response and risky decision-making. Adolescents who have a stronger physiological stress response (mostly those in the peer evaluator condition) will experience more self-conscious emotions and in turn have more difficulty making sound decisions during the risky decision-making task.

Research Question 7. *Does a history of peer victimization leave adolescents more vulnerable to experience self-conscious emotions under stressful peer conditions?*

Hypothesis 7. A history of peer victimization will leave adolescents more vulnerable to experience self-conscious emotions. Specifically, adolescents who have more past experiences

of peer victimization will experience more self-conscious emotions especially under stressful peer evaluations. Adolescents who have fewer past experiences of peer victimization will experience fewer self-conscious emotions when under adolescent evaluations.

Research Question 8. *Does resistance to peer influence act as a buffer to protect against self-conscious emotions under stressful peer conditions?*

Hypothesis 8. Resistance to Peer Influence will act as a buffer to protect against self-conscious emotions under stressful peer evaluations. Adolescents with high resistance to peer influence will exhibit lower levels of self-conscious emotions. This effect will be exaggerated when adolescents are evaluated by peers- adolescents who are evaluated by peers who have high resistance to peer influence will exhibit the lowest levels of self-conscious emotions. And, adolescents who are evaluated by peers who have low resistance to peer influence will exhibit the highest levels of self-conscious emotions.

Research Question 9 (exploratory). *How do salivary cortisol and salivary alpha amylase, together, influence adolescent risk-taking?*

Hypothesis 9. As discussed in the literature review section, the psychobiology of stress involves multiple coordinated systems with multiple, interacting biological components. It will thus be important to explore how cortisol (a marker of hypothalamic-pituitary-adrenal axis activity) and alpha amylase (a marker of sympathetic nervous system activity), together, operate in the hypotheses described above. The hypothalamic-pituitary-adrenal (HPA) axis is activated by social evaluative threat. The sympathetic nervous system (SNS) is also activated by social evaluative threat and social exclusion (Stroud et al., 2009) and negative emotionality (Byrd-Craven, Granger & Auer, 2010). Considering adolescents have difficulty making decisions in

social contexts with emotional stimuli, it is possible that adolescents who exhibit both high HPA activity and high SNS activity will be at most risk for making risky decisions.

III. Research Design and Methods

Participant Recruitment Methods

Adolescents from the local community were recruited via three different methods for the study. First, families who were previously involved in an infant study using birth records obtained from the State of California Department of Public Health were identified for the current dissertation. Specific details on the recruitment of these families are described in detail elsewhere (Lukowski & Milojevich, 2013). For the current dissertation, families who had male adolescents between the ages of 12 and 16 were identified. This resulted in 139 adolescents who were deemed suitable to contact for study participation. Of these 139 adolescents, 92 (66.19%) were unreachable (phone number was disconnected, phone number was incorrect, or never answered the phone or returned messages). Of the remaining 47 adolescents, 25 (53.19%) declined to participate in the study, 2 (4.26%) were ineligible due to use of prescription medications, and 20 (42.55%) were successfully recruited into the study. Overall, these 20 adolescents, accounted for 33.33% of the total sample (N = 60).

Second, study flyers were posted around Orange County. Flyer instructions requested that interested adolescents call, send a text, or send an email to a listed phone number or email address. A total of 59 adolescents contacted me with an interest in participating in the study. Of these 59 adolescents, 20 (33.90%) were unreachable (e.g. never answered or returned messages), 6 (10.17%) declined to participate in the study after receiving more study details, 1 (1.69%) was ineligible (due to use of prescription medication), and 32 adolescents (54.24%) were successfully

recruited into the study. Overall, these 32 adolescents accounted for 53.33% of the total sample (N = 60). Interested adolescents were asked at which location they saw the flyer. However, most adolescents were unable to recall exactly where they saw the flyers. Further, several interested adolescents heard about the study from a friend who saw the flyer and therefore could not provide information on the location of the flyer. As such, we were unable to identify if and which flyer locations were more successful in attracting interested adolescents.

The third method of recruitment was through a Peer Locator Sheet (Appendix A). After participants completed the study, they were asked to complete a form with the names and phone numbers of any peers who they thought would be interested in participating in the study, who were male, and who were between the ages of 12 and 16. In total, this resulted in 82 peers who were contacted for study participation. Of these 82 peers, 49 (59.76%) were unreachable (e.g. phone number was incorrect or never answered calls or returned messages), 25 (30.49%) declined to participate in the study, and 8 (9.76%) were successfully recruited into the study. Overall, these 8 adolescents accounted for 13.33% of the total sample (N = 60). One concern about the Peer Locator Sheet recruitment method was that participants would tell their peers about their experiences in the study, thus compromising Peer Locator Sheet recruited participants' data. As such, it was part of my protocol to tell participants to refrain from informing any of their peers about the nature of the study. Further, several indicators suggest that study participants who were recruited through the Peer Locator Sheet method were not informed of the details of the study by their peer who had recommended them. For example, compared to participants who were recruited through other methods, Peer Locator Sheet recruited participants did not exhibit stronger biological responses to the Trier Social Stress Test (TSST) as measured by their increase in salivary cortisol production before and after the TSST, ($t(54) = -0.07, p =$

0.941), their increase in salivary alpha-amylase production before and after the TSST, ($t(52) = -0.41, p = 0.685$). Compared to participants who were recruited through other methods, Peer Locator Sheet recruited youth did not appraise the TSST as more or less threatening, ($t(56) = -0.12, p = 0.905$) nor did they experience more or less negative emotions ($t(56) = -0.10, p = 0.921$), positive emotions ($t(56) = -.37, p = .714$), or self-conscious emotions ($t(56) = -.54, p = .591$) immediately after the TSST. Additionally, compared to participants who were recruited through other methods, Peer Locator Sheet recruited youth did not make more risky decisions on the Stoplight Task, ($t(57) = -1.14, p = 0.259$). These null findings illustrate that on key variables, there were no differences between Peer Locator Sheet recruited participants and participants recruited through other methods. This suggests that Peer Locator Sheet recruited participants did not have more knowledge of the study.

Eligibility

After contact information was obtained (through the recruitment methods described above), trained research assistants made calls to recruit participants into the study. During these calls, eligibility criteria were checked. All participants recruited into the study were 1) male, 2) between the ages of 12 and 16, 3) fluent in English, 4) had no serious medical problems, 5) had no serious mental health problems, 6) were not taking any prescription medications that would interfere with nervous system or hypothalamus-pituitary-adrenal axis functioning, 7) did not smoke cigarettes, and 8) had never previously participated in a research study that used the Trier Social Stress Test. The age range of 12 to 16 years was selected because prior research has illustrated that around age 14, adolescents' susceptibility to peer influence peaks (Erickson, Crosnoe, & Dornbusch, 2000; Sumter, Bokhorst, Steinberg, & Westenberg, 2009). Considering that not all adolescents are on the exact same developmental timeline, a sample with this age

range would include adolescents who were highly sensitive to peers, but who also exhibited individual variation in sensitivity to peer influence. This variability was key in several main analyses in the current dissertation. Due to the original survey questions being written in English and many not yet being validated among adolescents speaking other languages, it was important that participants were also fluent in English. Eligibility criteria 4 through 7 (had no serious medical problems, had no serious mental health problems, were not taking any prescription medications, did not smoke cigarettes) were included due to past research showing these factors could interfere with nervous system functioning (Compas, Connor-Smith, & Jaser, 2004; Granger, Hibel, Fortunato, & Kapelewski, 2009; Spear, 2009). Finally, due to habituation effects of the TSST (Kudielka, Hellhammer, Kirschbaum, Harmon-Jones, & Winkielman, 2007), any adolescents who reported having previously participated in the TSST were deemed ineligible for study participation.

An additional eligibility check was performed for all adolescents who participated in the study; the final set of questions that participants were asked at the end of the study were the same eligibility questions that they were asked over the phone while being recruited. Four adolescents reported being on prescription medications. However, these medications have not been found to interfere with hypothalamus-pituitary-adrenal axis or nervous system functioning (e.g. having used an inhaler for asthma three months ago). Finally, all participants were called the day before their scheduled appointments to be reminded of their appointment at which time they were asked to abstain from consuming caffeine on the day of their appointment, as doing so could interfere with hypothalamus-pituitary-adrenal system functioning (Saxbe, 2008).

Sample

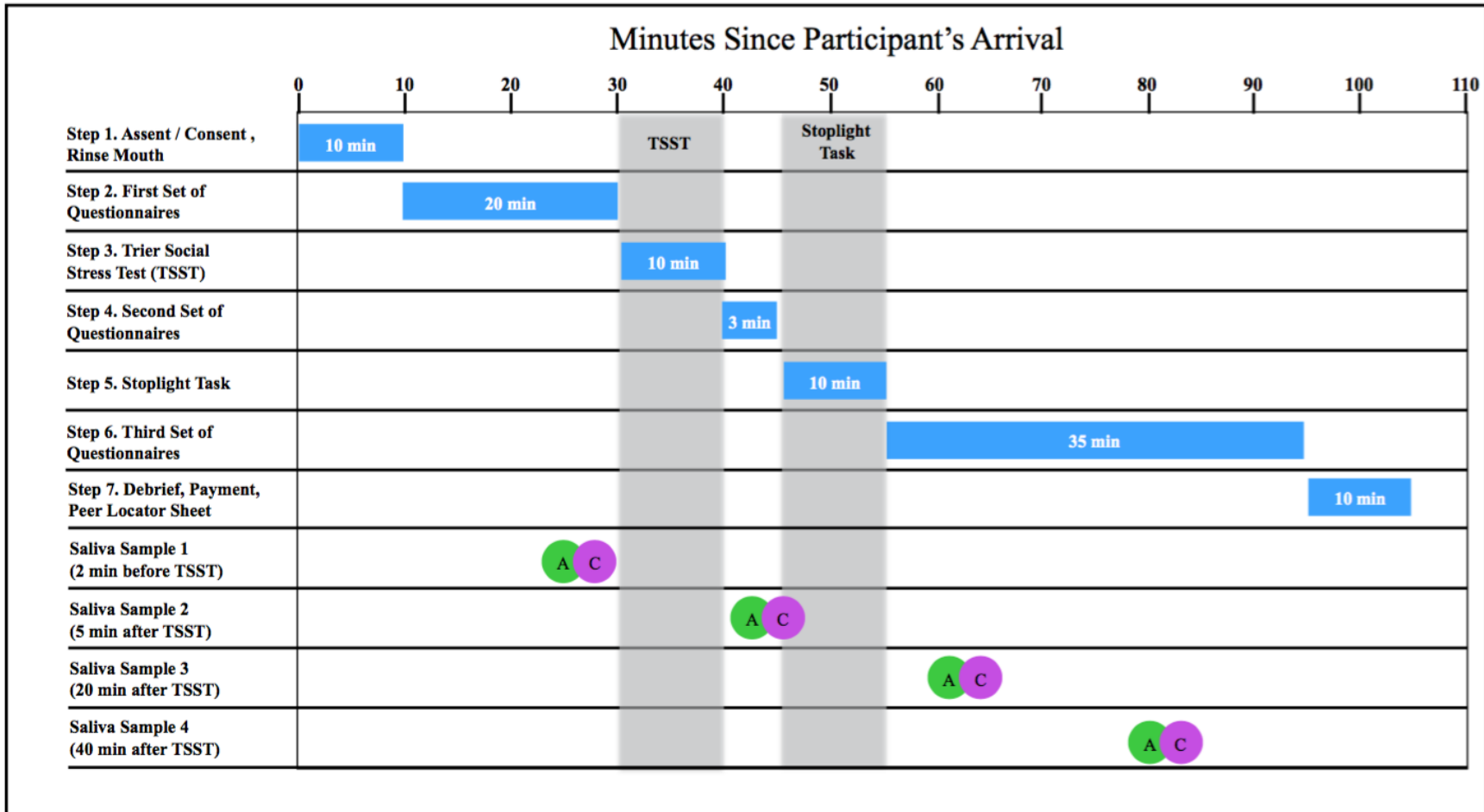
Based on previous work using similar designs comparing an experimental and control TSST conditions (Dickerson & Kemeny, 2004), it was necessary to recruit a minimum sample of 40 adolescent participants (20 participants in the peer-evaluator and 20 participants in the adult-evaluator conditions). The final sample included 60 male adolescents aged 12 to 16 years ($M = 13.98$, $SD = 1.13$). The racial makeup of the sample was 46.67% White, 25% Latino, 15% Asian, 6.67% Black, and 6.67% Other. This is reflective of the racial composition of Orange County which is estimated to be 41.4% White, 34.4% Latino, 20.1% Asian, 2.1% Black, and 2% Other (United States Census Bureau, 2015). 62.71% of adolescents had at least one parent who had a college degree.

Procedures

Overview. Adolescents were asked to come to the University of California, Irvine to participate in the current dissertation. Study participation took approximately 1 hour and 45 minutes and included a) consent and assent procedures, b) a battery of self-report surveys, c) a social stressor, the Trier Social Stress Test, d) a computerized driving game, the Stoplight Task, to assess risky decision-making, and e) debriefing procedures (Figure 1). Adolescents were randomly assigned to one of two Trier Social Stress Test (TSST) conditions, the peer-evaluator TSST condition or the adult-evaluator condition. While the peer-evaluator condition involved a panel of evaluative adolescents, the adult-evaluator condition involved a panel of evaluative adults. Throughout the study session, 4 whole saliva samples were collected-- 2 minutes before the TSST, and 5, 20, and 40 minutes after the TSST. Saliva samples were assayed for salivary cortisol and salivary alpha-amylase at the University of California, Irvine's Institute for

Interdisciplinary Salivary Bioscience Research. This schedule of sampling allowed for the identification of peak outputs and recovery patterns of both cortisol and alpha-amylase (Granger, Kivlighan, El-Sheikh, Gordis, & Stroud, 2007; Kudielka et al., 2007).

Figure 1. Detailed Timeline of Study Session



Note: A = alpha-amylase. C = cortisol.

Consent. Since participants were minors, it was required that a parent or legal guardian provide written consent. As such, all adolescents were asked to come to a laboratory at University of California, Irvine with a parent/legal guardian. First, the parental consent form (Appendix A) was briefly explained to parents by a trained research assistant. Research assistants were undergraduate students from the University of California, Irvine who were interested in gaining research experience in exchange for course credit. Then, the parent/legal guardian was given time to review the document. Finally, the parent/legal guardian was given the opportunity to ask any questions before signing the document.

While parents/legal guardians provided written consent, adolescents provided verbal assent after research assistants informed them of the study via a Study Information Sheet (Appendix A). All consent and assent procedures were approved by the University's Institutional Review Board. Following consent and assent procedures, adolescents were taken to a different room to complete the study. That is, parents/legal guardians did not accompany them.

Self-report surveys. A total of 15 self-report surveys were administered to participating adolescents. Adolescents completed all self-report surveys with a trained research assistant. Research assistants were trained to guide adolescents through self-report surveys in a standardized manner. In a private room, they read instructions, questions, and response options out loud from all self-report surveys. This was done in an effort to both standardize the interview across adolescents but also to address any limitations or variability in adolescents' reading comprehension. Broadly, self-report surveys tapped into domains such as demographic background and socioeconomic status, experiences with peers, mental health, behavioral proclivities such as sensation seeking and impulsivity, and subjective assessments of adolescents' TSST experience.

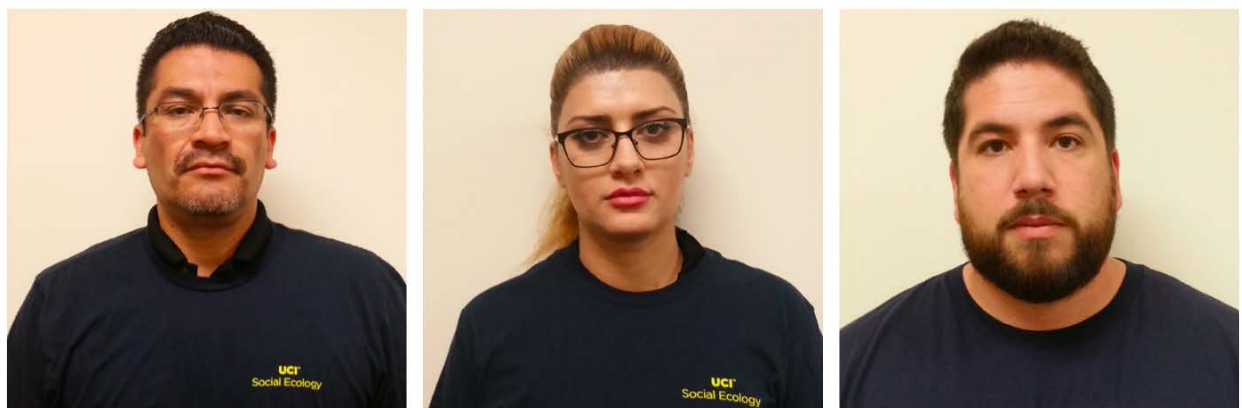
Social stressor and social stressor conditions. The Trier Social Stress Test (TSST) was used to induce social stress among adolescents. The TSST has proven an effective method of inducing stress among adolescents (Dickerson & Kemeny, 2004; Gunnar, Talge, & Herrera, 2009). Broadly, adolescents were asked to deliver a 5-minute speech about themselves (a mini autobiography) to confederate evaluators. Confederate evaluators were trained to provide no feedback throughout the task by keeping a neutral facial expression and refraining from gestures such as head nodding. The autobiography was then followed by a math task during which adolescents were asked to solve challenging algebraic math tasks aloud.

Adolescents were randomly assigned to one of two TSST conditions. Adolescents in the peer-evaluator TSST condition were evaluated by three adolescents with whom they had no previous interactions. Adolescents in the adult-evaluator condition were evaluated by three adults (aged 30+ years) with whom they had no previous interactions. Panels of both adolescent and adult evaluators were always comprised of at least one male and one female evaluator. To my knowledge, no prior research has examined the effect of gender composition of evaluator panels in the TSST on adolescent adolescents (Dickerson & Kemeny, 2004). However, adolescence is a developmental period when romantic relationships become more important and more frequently sought out (Connolly, McIsaac, Underwood, & Rosen, 2011). In the case that adolescents are more or less reactive to same or opposite-gendered evaluators, it was necessary for both male and female genders to be represented in evaluator panels. Figures 2 and 3 provide photos of evaluators from both adolescent and adult panels.

Figure 2. Three Evaluators from the Peer-evaluator Trier Social Stress Test Condition¹



Figure 3. Three Evaluators from the Adult-evaluator Trier Social Stress Test Condition



Importantly, adolescent and adult evaluators were trained using the exact same training method and materials. Specifically, during the TSST, adolescent and adult evaluators read from the same script to inform adolescents what to do (Appendix A). This script was written to reflect realistic language that would be believable if delivered by either the adult or adolescent evaluator panels. Additionally, traditional protocol for the TSST often includes evaluators wearing white laboratory coats (Dickerson & Kemeny, 2004). It would be unbelievable and strange for the adolescent evaluators to wear white laboratory coats as adolescents are not often in white

¹ Permission to include photographs of peer and adult evaluators was obtained.

laboratory coats. As such, both adult and adolescent evaluators wore the same University of California, Irvine shirts.

Saliva Collection and Assay. Throughout the study session, 4 whole saliva samples were collected-- 2 minutes before the TSST, and 5, 20, and 40 minutes after the Trier Social Stress Test (TSST). This schedule of sampling allowed for the identification of peak outputs and recovery patterns of both cortisol and alpha-amylase (Granger, Kivlighan, El-Sheikh, et al., 2007; Kudielka et al., 2007). Cortisol is more “slow-responding” with evidence that salivary cortisol peaks around 20 minutes following a social stressor. Conversely, alpha-amylase is more “fast-responding” with evidence that salivary alpha-amylase peaks around 5 minutes following a social stressor. As such, the third saliva sample, collected 20 minutes after the TSST was used as an index of peak cortisol, and the second saliva sample, collected 5 minutes after the TSST was used as an index of peak alpha-amylase. The first saliva sample, collected 2 minutes before the TSST, was used as a baseline index for both cortisol and alpha-amylase. Importantly, this first saliva sample was collected about 25 minutes after the adolescent arrived at the lab, giving the adolescent adequate time to acclimate to the new environment. For detailed illustration of sampling timeline in relation to other study procedures, see Figure 1. Adolescents (N = 60) provided 4 samples. However, some samples had insufficient volume for assaying and thus were not able to be included. A total of 56 samples were assayed for cortisol at TSST-2, 56 samples were assayed for cortisol at TSST+5, 56 samples were assayed for cortisol at TSST+20, 56 samples were assayed for cortisol at TSST+40, 55 samples were assayed for alpha-amylase at TSST-2, 54 samples were assayed for alpha-amylase at TSST+5, 54 samples were assayed for alpha-amylase at TSST+20, and 55 samples were assayed for alpha-amylase at TSST+40. Insufficient volume for assaying was the sole reason for unsuccessful attempts to assay samples.

Before primary study measures were administered, a trained research assistant asked the adolescent to rinse his mouth with water to ensure that no food or drink particles could compromise saliva samples. Since rinsing may dilute salivary analytes (Granger, Kivlighan, Fortunato, et al., 2007), the first saliva sample was collected at least 15 minutes after adolescents rinsed their mouths to allow for salivary analytes to return to undiluted levels. Further, adolescents were not allowed to consume any food or drink during the remainder of the study. Saliva samples were collected using the passive drool technique. This involved adolescents using a ventilated tube to slowly push or blow saliva from their mouths into a 2 millimeter cryovial tube. For each saliva sample, adolescents were instructed to try to meet the goal of providing 1 millimeter of saliva during a 2 minute period. If they reached 1 millimeter before the 2 minute period, they were instructed to stop. If 2 minutes passed and they still had not yet reached the 1 millimeter goal, they were still instructed to stop. Trained research assistants tracked both the volume of saliva each adolescent provided for each saliva sample as well as the time the adolescent spent providing the sample (always < 2 minutes). From these markers of volume and time, adolescents' salivary flow rates were calculated (= saliva sample volume in millimeters / saliva sample collection duration in minutes). All adolescents were called the day before their scheduled appointments to be reminded of their appointment. During this call, adolescents were also asked to abstain from consuming caffeine on the day of their appointment as doing so could interfere with nervous system functioning (Saxbe, 2008).

All samples were transported on ice to the University of California, Irvine's Institute for Interdisciplinary Salivary Bioscience Research and stored frozen at 80 °C until assayed for cortisol and alpha-amylase. On the day of testing, all samples were centrifuged at 3000 rpm for 15 min to remove mucins.

Debriefing and payment. After study session completion, adolescents were debriefed on the study. Specifically, they were informed that the evaluators in the TSST were trained to not give any positive feedback. Further, adolescents were given more details about the true aims of the study. Following debriefing, adolescents were paid \$25 in cash. After payment, they were asked to complete the Peer Locator Sheet form (Appendix A) to recommend any friends that they thought might be interested in participating in the study, who were male, and who were between 12 and 16 years of age.

Study Measures

Demographics. Adolescents were asked to self-report their age and the race/ethnicity with which they identify. Additionally, adolescents were asked to report their parents' highest level of education. This was used as a proxy for socioeconomic status (SES), and other research has illustrated that this method for measuring SES can be used with children as young as 10 years old (Cauffman et al., 2010).

Self-Conscious Emotions. The Positive and Negative Affect Scale (Crawford & Henry, 2004; Laurent et al., 1999) was used to measure affective states before and after the TSST. The PANAS is a widely used and validated measure typically implemented before and after an emotional experience. For this study, the PANAS was administered both immediately before and immediately after the Trier Social Stress Test (TSST) to measure changes in affect. Four items (ashamed, humiliated, self-conscious, and embarrassed) were used to assess state-levels of self-conscious emotions. These emotions have been used in previous work in similar ways to measure self-conscious states (Derogatis, 1975). Adolescents were asked how much they felt each emotion "right now." Responses were recorded using a 5-point Likert scale ranging from 1 "very slightly or not at all" to 5 "extremely." A composite variable was constructed by summing

the values of each item and as such, the scale ranges from 4 to 20. For self-conscious emotions before the TSST, the alpha coefficient was 0.46 (suggesting very low internal consistency).² For affective states after the TSST, the alpha coefficient for the items was 0.84 (suggesting high internal consistency).

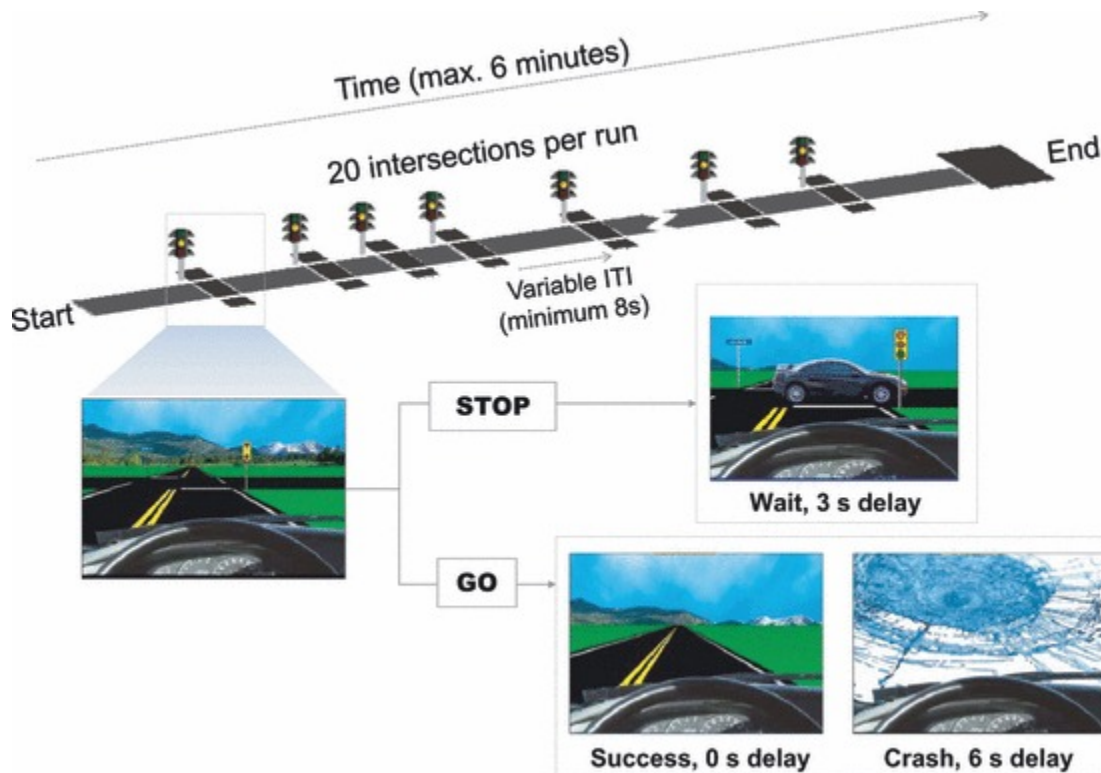
History of Prior Risky Behavior. Adolescents who have a proclivity towards risk-taking may be naturally inclined to take more risks during the risky decision-making driving paradigm. Additionally, there is evidence that adolescents' natural proclivity towards risk-taking predicts their risk-taking behaviors in stressful conditions (Johnson et al., 2012). As such, the Risky Behavior Protocol was used to assess adolescents' proclivity towards risk-taking behaviors (Conger, Elder, & Glen, 1994). Prior research has shown that the Risky Behavior Protocol has good internal consistency among adolescents for self-reported risky behavior (*Cronbach's alpha* = .73) and has been correlated with other measures of externalizing behaviors in various school and familial contexts (Rudasill, Reio, Stipanovic, & Taylor, 2010). Adolescents were first asked to think about their life for the past year and to report on whether they engaged in sixteen items (e.g. "Done something dangerous on a dare"). Items were rated using a binary scale with one option being "never" and the other option being "once or more than twice." In the current study, the alpha coefficient for the sixteen items was 0.77, suggesting that the items have acceptable internal consistency.

Current Risky Decision-Making. The Stoplight Task was used to measure individual differences in risky decision-making (Gardner & Steinberg, 2005). During a simulated driving

² The alpha coefficient for self-conscious affect before the Trier Social Stress Test (TSST) was very low. This likely reflects the fact that prior to the TSST, there were generally low levels of self-conscious affect with each participant experiencing various and perhaps discrepant levels of each of the four emotions. However, the high alpha coefficient for self-conscious affect after the TSST suggests that the items included were strong and reliably assess self-conscious affect after an experience that elicits higher levels of self-conscious affect.

game, adolescents were incentivized (told they would receive more points) to drive quickly through a driving course (get to the end of the course as quickly as possible). Randomly throughout the course, however, are stoplights, which are yellow as the driver approaches. The adolescent must choose between risking crashing by going through the yellow light or stopping at the yellow light. Successfully going through the yellow light without a crash increases the number of points the adolescent receives because it saves the driver time (he does not have to wait for the yellow light). However, crashing or stopping at the light decreases the amount of points the adolescent receives due to lost time. For each adolescent, a crash index was calculated. Crash index was a proportion reflecting the number of times an adolescent crashed in relation to the number of times there was an opportunity to crash and ranges from 0 to 1 with higher scores indicating more risky decision-making. The Stoplight Task is widely used and has been correlated to several factors that represent adolescent risky decision-making such as self-reported health risk behaviors (Kim-Spoon et al., 2016), self-reported risk-taking behaviors and impulsivity (Reilly, Greenwald, & Johanson, 2010), and even real-world driving behaviors (T. G. Brown et al., 2016). Further, it has been demonstrated that adolescents' performance on the task is influenced by both older (Telzer, Ichien, & Qu, 2015) and similarly-aged (Gardner & Steinberg, 2005) spectators.

Figure 4. The Stoplight Task (illustration from Chein, Albert, O'Brien, Uckert, & Steinberg, 2011)



Peer Victimization. The Social Experience Questionnaire Self Report (Crick & Grotpeter, 1996) measures adolescents' experiences with peer-instigated relational aggression. The measure consists of 5 items (e.g. "How often do other students leave you out on purpose when it is time to play or do an activity") that adolescents respond to using a 5-point Likert scale ranging from 1 "never" to 5 "all the time." Responses are summed to derive a total score with higher values reflecting more experiences of being the target of peer-instigated relational aggression. Internal consistency of the subscales has been found to be adequate to high across several independent samples with *Cronbach's alpha* reports ranging from .72 to .92 (Crick & Grotpeter, 1996; Crick, 1995; Crick & Bigbee, 1998). Further, the measure has been validated using adolescents (Storch, Crisp, Roberti, Bagner, & Masia-Warner, 2005). In the current

sample, the alpha coefficient was 0.73, suggesting that the items have moderate internal consistency.

Resistance to Peer Influence. The Resistance to Peer Influence measure was developed to assess the degree to which adolescents act autonomously in interactions with their peer group. The scale was originally developed for the Pathways to Desistance Study (Schubert et al., 2004). Adolescents are first presented with two conflicting scenarios (e.g., "Some people go along with their friends just to keep their friends happy" and "Other people refuse to go along with what their friends want to do, even though they know it will make their friends unhappy") and are then asked to choose the scenario that most closely reflects their behavior. Finally, the adolescent is asked to rate the degree to which the statement is accurate (i.e. "sort of true" or "really true"). Ten such sequences are presented to the adolescent, each exploring a different dimension of potential influence: go along with friends, fitting in with friends, changing their mind, knowingly do something wrong, hiding true opinion, breaking the law, changing the way you usually act, taking risks, saying things don't really believe, and going against the crowd. The alpha coefficient for the ten items was 0.80, suggesting that the items have acceptable internal consistency. Additionally, regarding external validity, the scale is significantly correlated with widely accepted measures of impulsivity and antisocial risk taking, constructs with which we would expect resistance to peer influence to be associated (Grisso et al., 2003).

Salivary Cortisol. As described, each adolescent was asked to provide 4 whole saliva samples using the passive drool technique. All samples were assayed in duplicate for cortisol. Several different indices for the two analytes were constructed for use in analyses. To assess the increase in analyte volume from baseline to peak response, a delta-peak value was obtained. This was calculated by taking the difference between an adolescent's peak level of the analyte (20

minutes after the TSST for cortisol and 5 minutes after the TSST for alpha-amylase) and the baseline measure (2 minutes before the TSST for both cortisol and alpha-amylase). Second, area under the curve scores were calculated using the trapezoidal formula in reference to ground to capture the overall level of analyte (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003).

Samples were assayed for salivary cortisol using a highly sensitive enzyme immunoassay. The test used had a lower limit of sensitivity of .007 $\mu\text{g/dL}$, range of sensitivity from .007 to 3.0 $\mu\text{g/dL}$ using neat saliva however the upper range can be extended by diluting the samples 1:10.

Before analyzing salivary cortisol data, several steps were taken to ensure that the data were reliable and valid. These steps included examining data parameters related to in-laboratory saliva assay procedures, assessing intra-assay and inter-assay precision, addressing outliers and zero values, transforming non-normal distributions of salivary data, and assessing general trends in observed data.

The standard curve is used as a reference to compute standard units of cortisol in adolescents' samples. As such, it is important that the standard curve is valid. One way to determine if the standard curve is valid is to assess the standard curve r-squared (*RSQ*). A perfectly valid standard curve would have an $RSQ = 1$. A total of 9 microtiter plates were used to assay salivary data (1 of which was used for retests). The *RSQs* ranged from .9996 to .9999, suggesting that the standard curves utilized as a reference for all cortisol assays were valid. Additionally, standards reflect the lower and upper expected range of cortisol in adolescents' saliva samples. In other words, the highest and lowest values of cortisol in adolescents' saliva samples should fall within the range of the standard curve. Thus, the range of the standard curve

was examined to ensure it included the highest and lowest values of cortisol in adolescents' saliva samples. More specifically, all samples were assayed in duplicate (assayed twice). Each duplicate was assessed to ensure it was within the range of the highest and lowest values of the standards. This was indeed the case for all individual duplicates. Individual duplicates ranged from a raw value of .021 $\mu\text{g/dL}$ to 1.557 $\mu\text{g/dL}$. The cortisol test used had a lower limit of detection of .007 $\mu\text{g/dL}$ and an upper limit of 3.0 $\mu\text{g/dL}$. The low upper and the high lower values of the standard curves (across microtiter plates) were 2.944 $\mu\text{g/dL}$ and .013 $\mu\text{g/dL}$, respectively. This suggests that the range of standards was large enough to detect cortisol levels for all assays; there were no non-detects nor zero values for cortisol. As such, no cortisol data was dropped for this purpose.

While there were no non-detects or zero values for cortisol, the data was still examined for outliers. An outlier was defined as any value 3 standard deviations above or below the mean (Hellhammer, Wüst, & Kudielka, 2009). This resulted in 1 cortisol value dropped at TSST-2, 1 cortisol value dropped at TSST+5, 2 cortisol values dropped at TSST+20, and 1 cortisol value dropped at TSST+40.

Intra-assay precision was examined using the intra-assay coefficient of variation (CV), which indexes the reliability of the assay for individual samples by comparing duplicate or triplicate samples. As noted, all samples in the current dissertation were assayed in duplicate, meaning that for each saliva sample, two raw values for cortisol were provided by the laboratory. The intra-assay CV was 4.9% on average across all samples suggesting reliability in the cortisol assays performed (Chard, 1990).

Inter-assay precision was also examined. As mentioned, 9 microtiter plates were used to perform cortisol assays for the current dissertation. Inter-assay precision is a measure of the

reliability of assays across microtiter plates. The inter-assay coefficient of variation (CV) was calculated for the low and high controls across microtiter plates. The inter-assay CV for low controls was 8.2%, and the inter-assay CV for high controls was 6.5%. Both were less than 10%, suggesting strong reliability of assays across microtiter plates (Chard, 1990).

The distribution of the raw salivary cortisol data was examined. As expected, raw salivary assay data was positively skewed with a disproportionate number of low-value cases (Granger et al., 2007). Log transformations were the most appropriate transformations for the current cortisol data (Miller & Plessow, 2013) and were applied to achieve adequate normalcy in the distributions of cortisol values at TSST-2 (*skew* = 1.32; *skew after transformation* = .01), TSST+5 (*skew* = 1.41; *skew after transformation* = -.27), TSST+20 (*skew* = 1.30; *skew after transformation* = -.52), and TSST+40 (*skew* = 1.84; *skew after transformation* = -.00).

For the construction of delta peak values, transformations were applied *after* construction if necessary. That is, instead of using transformed data to create delta peak scores, delta peak scores were first created and then transformed if necessary. The distribution of delta peak values for cortisol was positively skewed with a disproportionate number of low-value cases (*skew* = 1.13). Log transformation was the most appropriate transformation (Miller & Plessow, 2013) and once applied, the distribution of delta peak values of cortisol approached more acceptable normalcy (*skew* = -.94).

Similar to the construction of delta peak values, AUC_{Ground} values were first calculated using non-transformed raw scores and then distributions were examined for normalcy. AUC_{Ground} values for cortisol were moderately skewed (*skew* = .70). However, applying log and square-root transformations did not improve normalcy and therefore no transformations were applied in order to preserve sample size.

Salivary Alpha-Amylase. Samples were assayed for alpha-amylase using a commercially available kinetic reaction assay. The assay employs a chromagenic substrate, 2-chloro-p-nitrophenol, linked to maltotriose. The enzymatic action of alpha-amylase on this substrate yields 2-chloro-p-nitrophenol, which can be spectrophotometrically measured at 405 nm using a standard laboratory plate reader. The amount of alpha-amylase activity present in the sample is directly proportional to the optical density increase (over a 2 min period) in absorbance at 405 nm.

Alpha-amylase data were examined before use in main analyses to assess data parameters related to in-laboratory saliva assay procedures, intra-assay and inter-assay precision, outliers and zero values, non-normal distributions, and general trends in observed data.

Salivary alpha-amylase data were examined for non-detects and zero values. Five samples were concluded to not have sufficient quantity to be assayed for alpha-amylase (coded as missing values, not zero values). Towards the upper limit of detection, two samples exceeded 400 U/mL and were rerun at a 1:800 dilution and then multiplied by 4. On the lower limit, no samples yielded values less than 2.0 U/mL, resulting in no non-detect or zero values.

Salivary alpha-amylase data were examined for outliers. An outlier was defined as any value 3 standard deviations above or below the mean (Hellhammer et al., 2009). This resulted in 2 alpha-amylase values dropped at TSST-2, 1 alpha-amylase value dropped at TSST+5, and 1 value dropped at TSST+20.

Intra-assay CV (consistency of the duplicates for each sample) was 3.1%. The intra-assay CV (consistency across microtiter plates) was calculated for the low and high controls across microtiter plates. The inter-assay CV for low controls was 7.8%, and the inter-assay CV for high controls was 8.8%. All CVs met recommended criteria (Chard, 1990).

The distribution of the raw salivary alpha-amylase data was examined. As expected, raw salivary assay data was positively skewed with a disproportionate number of low-value cases (Granger et al., 2007). Square root transformations were the most appropriate transformations for the current alpha-amylase data (Miller & Plessow, 2013) and were applied to achieve adequate normalcy in the distributions of cortisol values at TSST-2 (*skew* = .94; *skew after transformation* = .02), TSST+5 (*skew* = 1.36; *skew after transformation* = .20), TSST+20 (*skew* = .86; *skew after transformation* = .08), and TSST+40 (*skew* = .77; *skew after transformation* = .05).

For the construction of delta peak values, transformations were applied *after* construction if necessary. That is, instead of using transformed data to create delta peak scores, delta peak scores were first created and then transformed if necessary. The distribution of delta peak values for alpha amylase was not skewed (*skew* = .16) and thus no transformation was applied to these scores.

Similar to the construction of delta peak values, AUC_{Ground} values were first calculated using non-transformed raw scores and then distributions were examined for normalcy. AUC_{Ground} values for alpha-amylase were moderately skewed (*skew* = .52). However, applying log and square-root transformations did not improve normalcy and therefore no transformations were applied in order to preserve sample size.

Salivary Flow Rate. Saliva sample collection duration (how long an adolescent spent providing each saliva sample) was collected using a stopwatch at the time of sample collection. Additionally, saliva sample volume was noted prior to sending samples to the laboratory for assaying. These measurements were used to derive salivary flow rate (= saliva sample volume in mL / saliva sample collection duration in minutes).

Plan of Analysis

Overall, three different types of main analyses will be used to address the research questions proposed. These include independent samples *t*-tests (to compare group means between adolescents in the peer-evaluator and adult-evaluator Trier Social Stress Test conditions), repeated measures Analysis of Variance (to compare group means while accounting for difference between condition while accounting for between-subject and within-subject effects), and multiple linear regression (to test associations between continuous variables while accounting for covariates). For regression models, covariates included adolescents' age, race, and parental education. Age was included as a covariate because many of the variables in the current models have been shown to change across age and be susceptible to development. For example, salivary alpha-amylase levels to acute stress have been found to be higher in children and lower in adults (Strahler, Mueller, Rosenloecher, Kirschbaum, & Rohleder, 2010). Additionally, it is well accepted that risky decision-making varies across the lifespan, peaking during adolescence (Cauffman et al., 2010). Race was included as a covariate due to evidence that cross-race social interactions can be particularly stressful (Sawyer, Major, Casad, Townsend, & Mendes, 2012). Parental education was included as a covariate as analyses of the current sample indicated that adolescents in the peer-evaluator condition were more likely to have a parent with a graduate or professional degree. Additionally, there is reason to believe that adolescents whose parents have obtained higher educational degrees (e.g. whose parents have graduate and professional degrees) could potentially feel more comfortable on a University campus compared to adolescents whose parents have not obtained higher education degrees (e.g. whose parents did not go to college). As such, parental education was included as a covariate. In addition, past research has shown that salivary analytes can be affected by salivary flow rate-

how quickly an adolescent is providing saliva. However, no consistent associations between salivary flow rate and analyte volume in the current data was found. As such, salivary flow-rate was omitted as a covariate in all analyses. When appropriate (i.e. when attempting to explain variability in self-conscious emotions after the TSST), self-conscious emotions before the TSST were included as a covariate. When appropriate (i.e. when attempting to explain variability in risky decision-making after the TSST), history of prior risky behavior was included as a covariate.

It is important to note that all models were run with and without covariates because although there were theoretically important reasons to include these covariates, they did not always explain variability in the regression models. When there were no differences between including and not including the covariates, models are presented with covariates. If findings were different between models that did and did not include covariates, this was noted and elaborated upon in the results section.

IV. Results

Preliminary Analysis of Salivary Data

Before addressing the main research question, preliminary analyses were conducted with the intention of assessing general patterns of change in salivary cortisol for the full sample (Table 1). Doing so provided evidence that, as a whole, participants were responsive to the Trier Social Stress Test. As expected, cortisol peaked 20 minutes after the TSST (TSST+20). A paired *t*-test confirmed that participants' mean baseline cortisol levels (TSST-2) and participants' mean cortisol levels 20 minutes after the TSST (TSST+20) were different, ($t(55) = -6.54, p < .001$). From baseline (TSST-2) to peak (TSST+20), cortisol levels increased an average of 88.98%, and

81.03% of the sample showed greater than a 10% increase in cortisol from baseline to peak. The average raw difference from baseline to peak for cortisol was $.09 \mu\text{g/dL}$ ($SD = .11$). For the full sample, cortisol did not return to baseline levels during the sampling schedule. That is, a paired t -test indicates that there is a difference between cortisol levels at baseline (TSST-2) and 40 minutes after the TSST (TSST+40), ($t(53) = -2.69$ $p = .009$), with final samples (TSST+40) reflecting higher mean levels of cortisol compared to baseline samples. This suggests that, on average, participants' cortisol levels did not fully recover (i.e. did not return to baseline levels) within the timeframe of the study.

Preliminary analyses were also to assess general patterns of change in salivary alpha-amylase for the full sample (Table 1). Doing so provided evidence that, as a whole, participants were responsive to the Trier Social Stress Test. As expected, salivary alpha-amylase peaked 5 minutes after the TSST (TSST+5). A paired t -test confirmed that participants' baseline alpha-amylase levels (TSST-2) and participants' alpha-amylase levels 5 minutes after the TSST (TSST+5) were different, $t(53) = -3.95$, $p < .001$. From baseline (TSST-2) to peak (TSST+5), alpha-amylase increased an average of 60.01%, and 90.74% of the full sample showed greater than a 10% increase in alpha-amylase from baseline to peak. The average raw difference from baseline to peak for alpha-amylase was 36.07 U/mL ($SD = 66.96$). A paired t -test confirmed that alpha-amylase returned to baseline levels by 20 minutes following the TSST (TSST+20). That is, there was no difference between alpha-amylase mean levels at baseline (TSST-2) and 20 minutes after the TSST (TSST+20), $t(53) = -1.00$ $p = .321$. This suggests that, on average, participants' alpha-amylase levels fully recovered (i.e. returned to baseline levels) by 20 minutes after the TSST.

Table 1. Observed Cortisol and Alpha-amylase by Trier Social Stress Test Condition								
		Full Sample (N = 60)		Peer-evaluator Condition (N = 34)		Adult-Evaluator Condition (N = 26)		Test Statistic
Cortisol ($\mu\text{g/dL}$)								
		<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	Test Statistic
	Raw Values							
	TSST-2	.16 (.12)	.03, .67	.13 (.11)	.03, .66	.19 (.11)	.04, .48	$t(54) = 2.91, p = .005$
	TSST+5	.20 (.16)	.02, .83	.18 (.16)	.02, .83	.24 (.16)	.03, .67	$t(54) = 1.71, p = .092$
	TSST+20	.26 (.21)	.03, 1.05	.23 (.18)	.03, .79	.31 (.24)	.04, 1.05	$t(54) = 1.53, p = .131$
	TSST+40	.20 (.18)	.03, .94	.17 (.16)	.03, .73	.25 (.20)	.04, .94	$t(54) = 1.86, p = .072$
	Delta Peak	.11 (.14)	-.06, .63	.10 (.12)	-.04, .51	.12 (.16)	-.06, .63	$t(54) = .445, p = .659$
	AUC _{Ground}	10.93 (8.26)	1.46, 41.30	9.36 (7.32)	1.46, 37.82	13.03 (9.11)	1.88, 41.30	$t(54) = 1.82, p = .074$
Alpha-Amylase (U/mL)								
	Raw Values							
	TSST-2	124.47 (87.64)	2.95, 370.48	125.75 (91.33)	2.95, 370.48	122.81 (84.55)	10.02, 343.48	$t(53) = -.06, p = .952$

	TSST+5	156.48 (96.57)	11.87, 371.49	147.01 (90.58)	16.56, 350.96	169.25 (104.80)	11.87, 371.49	$t(52) = .68, p = .500$
	TSST+20	129.29 (85.06)	8.86, 369.16	128.43 (83.57)	8.85, 369.16	130.45 (88.92)	13.51, 309.06	$t(52) = .01, p = .990$
	TSST+40	133.69, 91.83	6.07, 366.05	129.13 (93.35)	6.07, 366.05	140.04 (91.35)	9.00, 340.50	$t(53) = .44, p = .665$
	Delta Peak	36.07 (66.96)	-133.33, 223.20	21.26 (71.49)	-133.33, 223.20	56.03 (55.74)	-30.73, 186.29	$t(52) = 1.94, p = .058$
	AUC _{Ground}	6902.43 (4179.84)	491.14, 16272	6724.85 (4126.03)	491.14, 16272	7141.77 (4332.48)	585.25, 15886.71	$t(52) = .28, p = .779$

Preliminary Analysis of Self-Report and Behavioral Measures

Before addressing main research questions, several descriptive statistics were conducted to examine general trends in self-report and behavioral data. Table 2 presents descriptive data for the full sample, the peer-evaluator condition, and the adult-evaluator condition. When appropriate, two-tailed t -tests were used to compare mean levels of a variable of interest between the two conditions. When appropriate, a chi-square test was used to compare differences in categorical variables of interest between the two conditions. There were no differences between adolescents in the two TSST conditions on their age ($t(57) = 0.46, p = .645$) and race ($\chi^2(4) = 4.73, p = .316$). Adolescents in the peer-evaluator condition were more likely to have at least one parent with a graduate degree while adolescents in the adult-evaluator condition were more likely to have at least one parent with a 4-year college degree ($\chi^2(3) = 14.57, p = .002$). As such, parental education was used as a covariate in all analyses. There were no differences between conditions on adolescents' self-conscious emotions before the TSST ($t(57) = 1.14, p = .260$), and the baseline measure of their risky behaviors ($t(57) = -1.02, p = .312$). There was a difference in adolescents' perceptions of evaluators ages between the two conditions with adolescents perceiving peer-evaluator to be younger than adult-evaluator, confirming that the manipulation of evaluators' age was effective, ($t(56) = 7.18, p < .001$). Finally, correlations were examined between all variables and are presented in Table 3.

Table 2. Description of Sample by Trier Social Stress Test Condition

		Full Sample (N = 60)		Peer-evaluator Condition (N = 34)		Adult-Evaluator Condition (N = 26)		Test Statistic
Demographics								
		<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	Test Statistic
Adolescents'	Age (in years)	13.98 (1.13)	12, 16	13.94 (1.23)	12, 16	14.08 (1.00)	13, 16	$t(57) = 0.46, p = .645$
		N	%	N	%	N	%	
	Race							
	White	28	46.67	17	50	11	44	$\chi^2(4) = 4.73, p = .316$
	Latino	15	25	6	17.65	9	36	
	Asian	9	15	5	14.71	4	16	
	Black	4	6.67	3	8.82	0	0	
	Other	4	6.67	3	8.82	1	4	
		N	%	N	%	N	%	
	Parent's Highest Education							
	High School	14	23.37	5	15.15	9	36	

	2-year College	7	11.86	5	15.15	2	8	$\chi^2(3) = 14.57, p = .002$
	4-year College	16	27.12	5	15.15	11	44	
	Graduate/ Professional	22	37.29	18	54.55	3	12	
Self-Conscious Emotions								
		<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>Test Statistic</i>
	Before TSST	5.77 (1.70)	4, 11	5.53 (1.69)	4, 11	6.04 (1.72)	4, 11	$t(57) = 1.14, p = .260$
	After TSST	8.09 (3.71)	4, 19	7.03 (2.94)	4, 15	9.48 (4.20)	4, 19	$t(56) = 2.61, p = .012$
Risky Behaviors and Risky Decision-Making								
		<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>Test Statistic</i>
	Risky Behavior Protocol	2.95 (1.62)	0, 7	3.12 (1.85)	0, 7	2.68 (1.25)	0, 5	$t(57) = -1.02, p = .312$
	Stoplight Task	.26 (.14)	.03, .68	.25 (.13)	.03, .68	.28 (.15)	.03, .63	$t(56) = .80, p = .430$
Peer-Related Factors								
		<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>M (SD)</i>	Min, Max	<i>Test Statistic</i>
	Peer Victimization	8.02 (2.67)	5, 15	7.94 (2.79)	5, 15	8.16 (2.73)	5, 14	$t(57) = .31, p = .761$
	Resistance to Peer Influence	3.11 (.41)	2.1, 4	3.16 (.43)	2.1, 4	3.06 (.37)	2.2, 3.7	$t(57) = -.90, p = .372$
Experimental Manipulation Check								

		M (SD)	Min, Max	M (SD)	Min, Max	M (SD)	Min, Max	<i>Test Statistic</i>
Adolescent's Perceptions of Evaluators'	Age (in years)	23.24 (8.52)	13, 55	17.81 (3.18)	13, 24	30.96 (8.63)	20, 55	$t(56) = 7.18, p < .001$
<p>Note: <i>Test Statistic</i> for <i>t</i>-tests given for two-tailed tests. Risky Behavior Protocol was used as a baseline measure of prior risky behaviors while the Stoplight Task was used as the measure of risky decision-making following the Trier Social Stress Test.</p>								

Table 3. Correlations among Self-report, Salivary, and Behavioral Data for Full Sample

	1	2	3	4	5	6	7	8	9	10
1. Age										
2. Cortisol Delta Peak	.19									
3. Cortisol AUC _{Ground}	.12	.65**								
4. Alpha-Amylase Delta Peak	.20 †	.15	.19							
5. Alpha-Amylase AUC _{Ground}	-.23 †	-.26 †	.07	.31*						
6. Self-Conscious Emotions Before TSST	.34*	-.08	.09	.07	-.04					
7. Self-Conscious Emotions After TSST	-.13	-.16	.03	.23*	.16	.09				
8. History of Risky Behaviors	-.00	-.11	.00	-.01	.01	.22 †	-.02			
9. Risky Decision-Making	.01	.02	-.10	.06	-.15	.24*	.04	.10		
10. Peer Victimization	.09	-.07	-.01	.28*	-.10	.02	.17	.27*	-.04	
11. Resistance to Peer Influence	.14	-.06	-.18	-.04	-.12	-.33**	-.27*	-.13	.03	.00

Note: TSST = Trier Social Stress Test. AUC_{Ground} = Area under the curve in relation to ground.

† $p < .10$

* $p < .05$

** $p < .01$

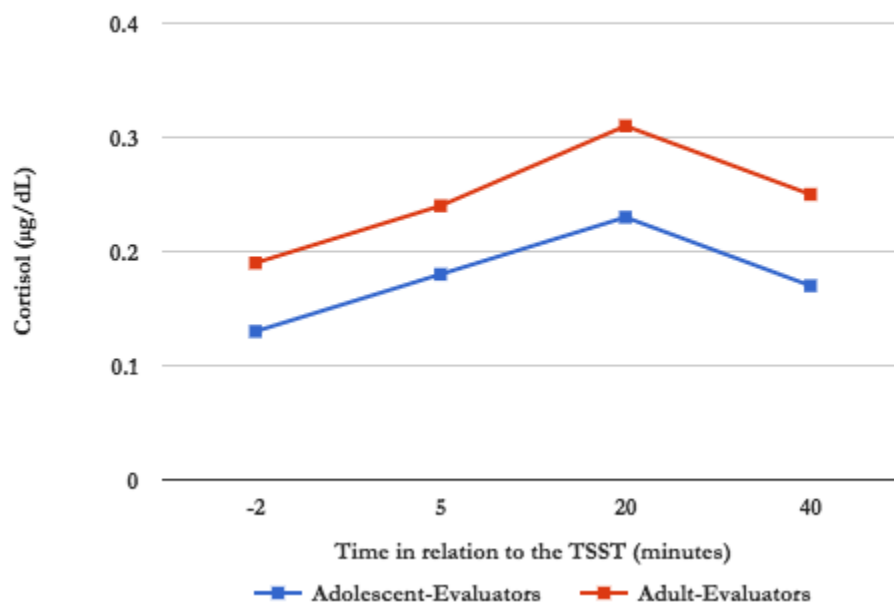
Research Question 1

Do adolescents experience more social stress (as measured by salivary cortisol and alpha-amylase) when being negatively evaluated by same-aged peers compared to when being negatively evaluated by adults?

To address the first research question regarding differences in physiological stress in response to either a peer or adult evaluator, several analytic approaches were used. First raw scores at each sampling time point (TSST-2, TSST+5, TSST+20, TSST+40) were compared between condition using independent samples *t*-tests. To measure differences in the increase in analyte volume from baseline to peak response, group mean differences of delta peak values (between adolescents in the peer-evaluator and adult-evaluator conditions) were examined using independent samples *t*-tests. Additionally, to assess differences in overall output of analytes, area under the curves with reference to ground (AUCg) were compared using an independent samples *t*-test. Finally, an analysis of variance (ANOVA) with repeated measures was used to assess group differences in the trajectory of analyte output. The between-subject effect was the TSST condition (peer-evaluator, adult-evaluator) and its error term was defined as subject nested within TSST condition. The within-subject effect factor was time (TSST-2, TSST+5, TSST+20, TSST+40). Greenhouse Gesier correction was used when appropriate. From the repeated measures ANOVA, two variables of interest were summarized. The first, the main effect of time, indicates whether there was a change in physiological stress across time from before the TSST to after the TSST. The second, the interactive effect of time-by-TSST-condition, indicates whether there was a significant difference in change in physiological stress across time between conditions.

The independent samples *t*-test showed that there was a difference in baseline (TSST-2) cortisol levels for peer-evaluator ($M = .126$, $SD = .114$) and adult-evaluator ($M = .194$, $SD = .110$) conditions, $t(54) = 2.91$, $p = .005$. In addition, a trend was observed for differences between conditions at TSST+5, $t(54) = 1.71$, $p = .092$ and TSST+40, $t(54) = 1.86$, $p = .072$. At all sampling time points (TSST-2, TSST+5, TSST+20 and TSST+40), adolescents in the adult-evaluator condition exhibited higher levels of cortisol (Table 1). Further, a trend was observed for differences between conditions' AUC_{Ground} scores $t(54) = 1.82$, $p = .074$, with adult-evaluator condition scores, on average, being higher. Although there was some evidence of differences in mean cortisol levels between groups, there was little evidence that *changes* in cortisol levels were different between groups. An independent samples *t*-test showed that there was no difference in delta-peak values between peer-evaluator and adult-evaluator conditions, $t(54) = .445$, $p = .659$. Repeated measures ANOVA was used to assess potential differences in cortisol between TSST conditions while accounting for both between-subject and within-subject effects. There was an effect of time on cortisol, $F = 21.42$, $p < .001$. Additionally, the effect of TSST condition was significant, $F = 4.42$, $p = .040$. However, the time-by-TSST-condition interaction was not significant, $F = .91$, $p = .435$, suggesting that adolescents' cortisol levels in the peer-evaluator compared to the adult-evaluator TSST conditions did not differ across time. A graph of observed response in cortisol based on TSST condition appears in Figure 5.

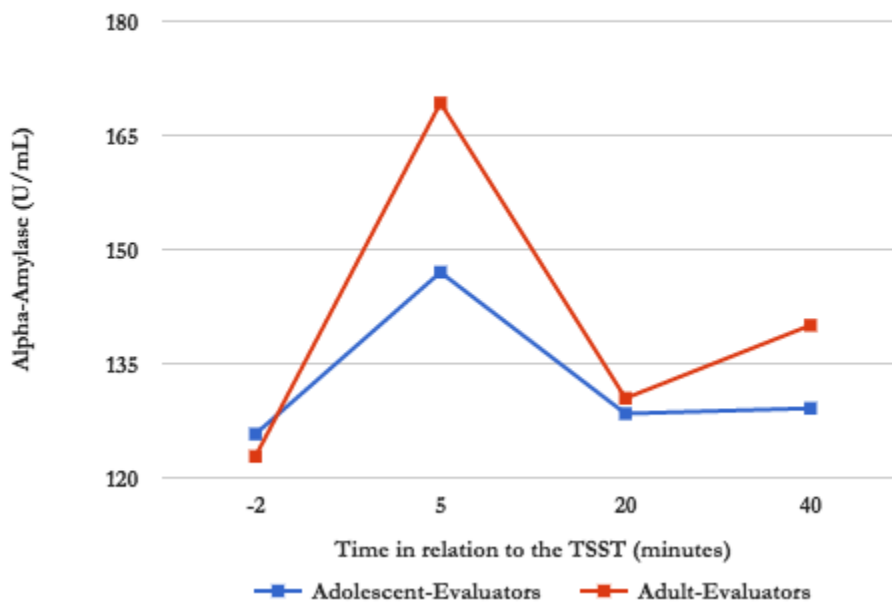
Figure 5. Observed Cortisol Response to the Trier Social Stress Test by Condition



For salivary alpha-amylase, independent samples *t*-test showed that there were no differences between TSST conditions at any sampling time points (Table 1). Further, differences between conditions' AUC_{Ground} scores were not significant ($t(52) = .282, p = .779$). Although there was no evidence of differences in overall alpha-amylase levels between groups, there was some evidence that *changes* in alpha-amylase were different between groups. An independent samples *t*-test showed a trend for a difference in delta-peak values between peer-evaluator and adult-evaluator conditions, $t(52) = 1.935, p = .058$. Repeated measures ANOVA was used to assess potential differences in alpha-amylase between TSST conditions while accounting for both between-subject and within-subject effects. There was an effect of time on alpha-amylase, $F = 10.02, p < .001$. However, the effect of TSST condition was not significant, $F = .19, p = .667$.

Nor was the time-by-TSST-condition interaction significant, $F = 1.60$, $p = .192$, suggesting that adolescents' alpha-amylase levels in the peer-evaluator compared to the adult-evaluator TSST conditions did not differ across time. A graph of observed response in alpha-amylase by TSST condition appears in Figure 6.

Figure 6. Observed Alpha-Amylase Response to the Trier Social Stress Test by Condition



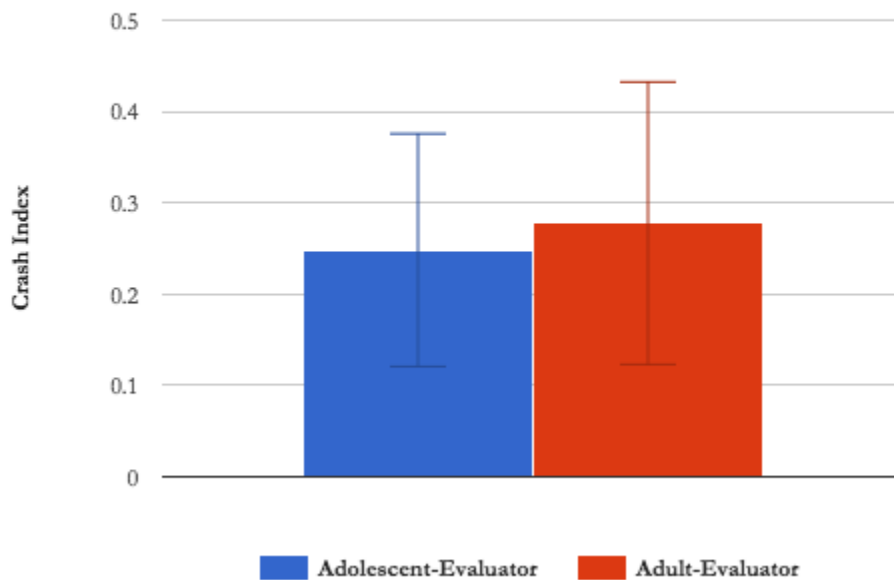
Research Question 2

After a stressful situation with peers, do adolescents take more risks compared to after a stressful situation with adults?

To address the second research question regarding differences in risky decision-making following the TSST, an independent samples t -test was conducted with the outcome variable risky decision-making and the grouping variable TSST condition (peer-evaluator or adult-evaluator).

The independent samples *t*-test showed that adolescents who were in a stressful situation with peers took just as many risks as adolescents who were in a stressful situation with adults (Figure 7).

Figure 7. Risky Decision-Making Between TSST Conditions



Research Question 3

Do adolescents feel more self-conscious when negatively evaluated by peers compared to when negatively evaluated by adults?

To address the third research question, three analyses were conducted. First, a one-sample *t*-test was used to examine if there were changes in self-conscious emotions before and after the TSST for the full sample, for the adolescents in the peer-evaluator condition, and for adolescents in the adult-evaluator condition. These *t*-tests examined within-person changes in self-consciousness. Second, an independent sample *t*-test was used to test for differences

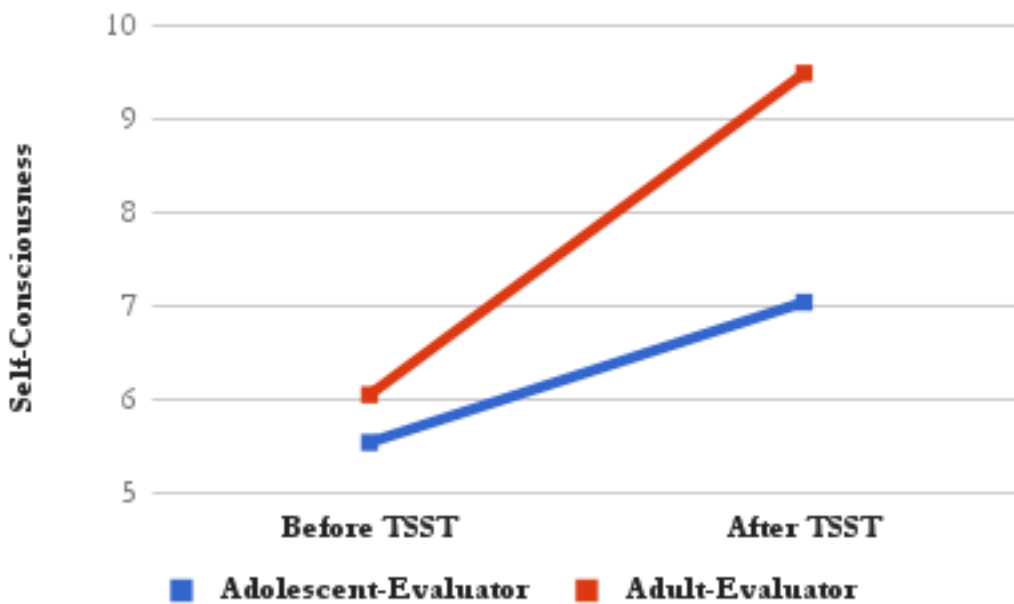
between conditions in self-conscious emotions. While *t*-tests can identify differences between conditions at one time point, a repeated measures design was used to confirm that changes across time points (from before the TSST to after the TSST) were dependent on condition. One repeated measures analysis of variance was conducted to test for differences between conditions on changes in self-conscious emotion. Between-subject effect was defined as TSST condition (peer-evaluator, adult-evaluator) and its error term was defined as subject nested within TSST condition. The within-subject effect factor was time (before TSST, after TSST).

For the peer-evaluator condition, adolescents experienced increases in self-conscious emotions before and after the TSST ($t(33) = -2.73, p = .010$). Similar patterns of emotional change among adolescents were observed in the adult-evaluator condition with increases in self-conscious emotions before and after the TSST ($t(24) = -3.69, p = .001$). Overall, regardless of condition, adolescents experienced increases in self-conscious emotions.

To investigate whether there were differences in self-conscious emotions between the two conditions, independent samples *t*-tests were conducted (Table 2). Before the TSST, there were no differences between the peer-evaluator and adult-evaluator TSST conditions on self-conscious emotions ($t(57) = 1.14, p = .260$). This confirms that the adolescents were not experiencing any differences in self-conscious emotions when they arrived to the lab. After the TSST, however, an independent samples *t*-test revealed that adolescents in the adult-evaluator condition compared to adolescents in the peer-evaluator condition experienced more self-conscious emotions, ($t(56) = 2.61, p = .012$).

While *t*-tests can identify differences between conditions at one time point (either before the TSST or after the TSST), a repeated measures analysis of variance was used to confirm that changes across time points (from before the TSST to after the TSST) were dependent on condition. For self-conscious emotions, there was an effect of time ($F = 24.58, p < .001$), confirming that on average, adolescents experienced a change in self-conscious emotions from time point 1 (before TSST) to time point 2 (after TSST). Additionally, there was also a significant time-by-TSST-condition interaction, ($F = 4.31, p = .043$), confirming that the change in self-conscious emotions (from before the TSST to after the TSST) was different between conditions. Surprisingly, adolescents in the peer-evaluator condition exhibited less of an increase in self-consciousness compared to adolescents in the adult-evaluator condition (Figure 8).

Figure 8. Changes in Self-Consciousness by TSST Conditions



Research Question 4

Do adolescents who feel self-conscious when negatively evaluated also exhibit stronger stress responses compared to adolescents who feel less self-conscious?

To address the fourth research question regarding the relation between physiological stress response and self-conscious emotions, multiple regression analysis were conducted. Four models were run and, for all models, the dependent variable was self-conscious affect after the TSST. In model 1, the main independent variable was cortisol delta peak scores. In model 2, the main independent variable was cortisol AUC_{Ground} scores. In model 3, the main independent variable was alpha-amylase delta peak scores. In model 4, the main independent variable was alpha-amylase AUC_{Ground} scores. For all models, covariates included adolescents' age, race (dummy coded white), parental education (dummy coded graduate/professional degree), TSST condition, and self-conscious affect before the TSST.

To test for an association between physiological stress response and self-conscious emotions, four regression models were conducted (Tables 4, 5, 6, and 7). For models 1, 2, and 4, (which measure physiological stress response using cortisol delta peak scores, cortisol AUC_{Ground} scores, and alpha-amylase AUC_{Ground} scores), there was no evidence that physiological stress response was related to self-conscious emotions. In model 3, when including covariates, there was a trend towards a relation between physiological stress response (as measured by alpha-amylase delta peak scores) and self-conscious emotions ($\beta = .24, t = 1.66, p = .104$). When omitting covariates, there was a relation between alpha-amylase delta peak scores and self-conscious emotions ($\beta = .28, t = 2.07, p = .043$), suggesting that heightened self-consciousness following the TSST is associated with a larger change in alpha-amylase from baseline to peak.

Table 4. Self-Conscious Emotions Regressed on Cortisol Delta Peak Values

Model 1					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	-.23	.60	-.07	-.38	.705
Race (0 = nonwhite, 1 = white)	-.70	1.30	-.09	-.54	.593
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	.15	1.36	.02	.11	.911
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-1.71	1.32	-.23	-1.30	.201
Self-Conscious Affect Before TSST	.09	.37	.05	.25	.806
Cortisol Delta Peak	-.48	.55	-.15	-.88	.387

Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.

Table 5. Self-Conscious Emotions Regressed on Cortisol AUC_{Ground}

Model 2					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	-.65	.48	-.21	-1.37	.179
Race (0 = nonwhite, 1 = white)	.16	1.15	.02	.14	.892
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.36	1.26	-.05	-.28	.778
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-1.81	1.19	-.24	-1.52	.135
Self-Conscious Affect Before TSST	.28	.33	.13	.84	.403
Cortisol AUC _{Ground}	-.00	.11	-.01	-.09	.930

Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.

Table 6. Self-Conscious Emotions Regressed on Alpha-Amylase Delta Peak					
Model 3					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	-.63	.49	-.19	-1.28	.207
Race (0 = nonwhite, 1 = white)	.11	1.08	.02	.10	.917
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	.09	1.25	.01	.07	.942
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-1.73	1.14	-.23	-1.52	.136
Self-Conscious Affect Before TSST	.22	.32	.10	.68	.502
Alpha-Amylase Delta Peak	.01	.01	.24	1.66	.104
Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test.					

Table 7. Self-Conscious Emotions Regressed on Alpha-Amylase AUC _{Ground}					
Model 1					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	-.37	.51	-.11	-.71	.479
Race (0 = nonwhite, 1 = white)	.27	1.10	.04	.25	.807
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.16	1.26	-.02	-.12	.901
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-2.02	1.53	-.27	-1.75	.086
Self-Conscious Affect Before TSST	.20	.33	.09	.61	.542
Alpha-Amylase AUC _{Ground}	.00	.00	.12	.88	.383
Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					

Research Question 5

Is social stress (as measured by salivary cortisol and alpha-amylase) related to subsequent risky decision-making among adolescents?

To address the fifth research question regarding the relation between physiological stress and risky decision-making, multiple regression analyses were conducted. Four models were run and, for all models, the dependent variable was risky decision-making. In model 1, the main independent variable was cortisol delta peak scores. In model 2, the main independent variable was cortisol AUC_{Ground} scores. In model 3, the main independent variable was alpha-amylase delta peak scores. In model 4, the main independent variable was alpha-amylase AUC_{Ground} scores. For all models, covariates included adolescents' age, race (dummy coded white), parental education (dummy coded graduate/professional degree), TSST condition, and history of risky behaviors.

To examine the relation between physiological stress response and risky decision-making, four regression models were conducted (Tables 8, 9, 10, and 11). Across models, there was no evidence that physiological stress response (as measured by cortisol delta peak scores, cortisol AUC_{Ground} scores, alpha-amylase delta peak scores, or alpha-amylase AUC_{Ground} scores) was related to risky decision-making. Results are the same whether covariates are included or omitted.

Table 8. Risky Decision-making Regressed on Cortisol Delta Peak					
Model 1					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	.00	.02	.03	.16	.873
Race (0 = nonwhite, 1 = white)	.00	.06	.00	.02	.987
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	.00	.06	.01	.03	.973
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.05	.06	-.15	-.83	.410
History of Risky Behaviors	.00	.02	.05	.27	.790
Cortisol Delta Peak	.00	.02	.02	.10	.923
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					

Table 9. Risky Decision-making Regressed on Cortisol AUC _{Ground}					
Model 2					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	.01	.02	.05	.31	.756
Race (0 = nonwhite, 1 = white)	-.03	.05	-.09	-.56	.581
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.00	.05	-.01	-.07	.947
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.03	.05	-.12	-.72	.474
History of Risky Behaviors	.00	.01	.02	.16	.872
Cortisol AUC _{Ground}	-.00	.00	-.16	.97	.313
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					

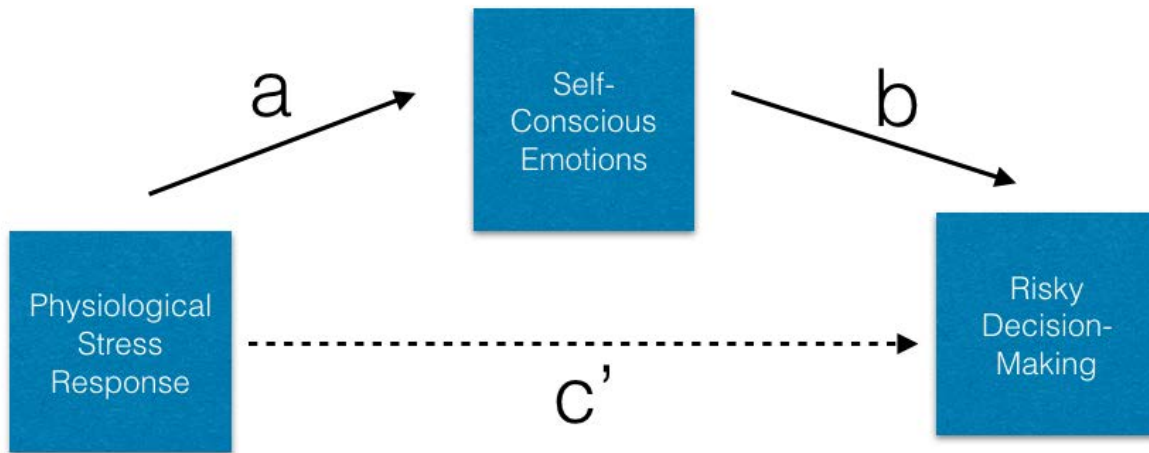
Table 10. Risky Decision-making Regressed on Alpha-Amylase Delta Peak					
Model 3					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	.01	.02	.08	.52	.607
Race (0 = nonwhite, 1 = white)	-.01	.04	-.04	-.27	.792
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	.00	.05	.02	.09	.930
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.03	.05	-.10	-.61	.545
History of Risky Behaviors	.00	.02	.03	.17	.865
Alpha-Amylase Delta Peak	.00	.00	.01	.06	.950
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					

Table 11. Risky Decision-making Regressed on Alpha-Amylase AUC _{Ground}					
Model 4					
	B	SE (B)	β	<i>t</i>	<i>p</i>
Age	.01	.02	.05	.31	.755
Race (0 = nonwhite, 1 = white)	-.01	.04	-.03	-.19	.850
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.00	.05	.01	-.06	.955
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.03	.05	-.10	-.64	.525
History of Risky Behaviors	.00	.01	.04	.25	.803
Alpha-Amylase AUC _{Ground}	.00	.00	-.14	-.90	.370
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					

Research Question 6

Do adolescents' self-conscious emotions help explain the relation between their physiological stress response and their risky decision-making?

Figure 9. Hypothesized mediational effect of self-conscious emotions



To address the sixth research question regarding the relation between physiological stress response, self-conscious emotions after the TSST, and risky decision-making, multiple regression analyses were conducted. Findings from Research Question 5 revealed that there was no relation between physiological stress response and risky decision-making. Findings from Research Question 4 revealed that there was a no relation between physiological stress response and self-conscious emotions after the TSST when using cortisol delta peak, cortisol AUC_{Ground} , or alpha-amylase AUC_{Ground} indices. However, there was a significant relation between physiological stress response as indexed by alpha-amylase delta peak values and self-conscious emotions after the TSST (pathway a in Figure 9). As such, to address Research Question 6, physiological stress response was indexed by alpha-amylase delta peak values. To test for the mediational effect of self-conscious emotions in the relation between physiological stress and

risky decision-making, two multiple regression analyses were conducted. For the first, stepwise multiple regression was conducted with risky decision-making as the dependent variable. In the first step, variables included: age, race, parental education, TSST condition, history of prior risky behavior, and alpha-amylase delta peak. In the second step, self-conscious emotions were included (pathway c' in Figure 9). For the second model, the dependent variable was risky decision-making and the main independent variable of interest was self-conscious emotions after the TSST (pathway b in Figure 9). Covariates included age, race, parental education, TSST condition, and history of prior risky behavior.

Regression analyses showed no evidence of the mediational effect of self-consciousness in the relation between physiological stress and risky decision-making (Tables 12 and 13).

Table 12. Relation Between Alpha-Amylase Delta Peak and Risky Decision-Making with and without Self-conscious Emotions after TSST					
	β	T	ΔR^2	F	df
Step 1			.02	.15	6, 46
Age	.07	.52			
Race (0 = nonwhite, 1 = white)	-.04	-.27			
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	.02	.09			
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.10	-.61			
History of Risky Behaviors	.03	.17			
Alpha-Amylase Delta Peak	.01	.06			
Step 2			.00	.12	7, 45
Self-Conscious Emotions After TSST	-.02	-.13			
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					
† $p < .10$					
* $p < .05$					

** $p < .01$

Table 13. Risky Decision-Making Regressed on Self-Conscious Emotions After the TSST

	B	SE (B)	β	t	p
Age	.00	.02	.02	.16	.875
Race (0 = nonwhite, 1 = white)	-.01	.04	-.02	-.12	.902
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.01	.05	-.04	-.23	.820
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.02	.05	-.08	-.51	.614
History of Risky Behaviors	.01	.01	.06	.41	.682
Self-Conscious Emotions After TSST	-.00	.01	-.02	-.10	.918

Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.

Research Question 7

Does a history of peer victimization leave adolescents more vulnerable to experience self-conscious emotions under stressful peer conditions?

To address the seventh research question regarding the relation between peer victimization and self-conscious emotions, stepwise multiple regression analysis was conducted. One model was presented with the dependent variable being self-conscious emotions after the TSST. In the first step, covariates included adolescents' age, race (dummy coded white), parental education (dummy coded graduate/professional degree), and self-conscious emotions before the TSST. In the second step, the main effects of TSST condition and peer victimization were

entered. In the third step, the interaction between TSST condition and adolescents' experiences of being victimized by peers was entered.

Stepwise multiple linear regression was conducted to examine whether a history of peer victimization left adolescents especially vulnerable to experience self-conscious emotions under stressful peer conditions (Table 14). Analyses revealed no significant effect of TSST condition and peer victimization. Results are the same whether covariates were omitted or included.

Table 14. Effect of Trier Social Stress Test condition and Peer Victimization on Self-Conscious Emotions					
	β	T	ΔR^2	F	df
Step 1: Covariates			.06	.84	4, 52
Age	-.19	-1.31			
Race (0 = nonwhite, 1 = white)	.07	0.48			
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.17	-1.23			
Self-Conscious Emotions Before TSST	.17	1.17			
Step 2: Main effects			.10	1.55	6, 50
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.28	-1.95†			
Peer Victimization	.16	1.22			
Step 3: Interactive effects			.00	1.35	7, 49
TSST Condition x Peer Victimization	-.24	-0.53			
Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					
† $p < .10$					
* $p < .05$					
** $p < .01$					

Research Question 8

Does resistance to peer influence act as a buffer to protect against self-conscious emotions under stressful peer conditions?

To address the eighth research question regarding the relation between resistance to peer influence and self-conscious emotions, stepwise multiple regression analysis was conducted. One model was presented with the dependent variable being self-conscious emotions after the TSST. In the first step, covariates included: adolescents' age, race (dummy coded white), parental education (dummy coded graduate/professional degree), and self-conscious emotions before the TSST. In the second step, the main effects of TSST condition and resistance to peer influence were entered. In the third step, the interaction between TSST condition and resistance to peer influence was entered.

Table 15 presents the stepwise multiple linear regression conducted to examine whether resistance to peer influence protected adolescents from experiencing self-conscious emotions after stressful peer conditions. Analyses revealed no significant effect of TSST condition and resistance to peer influence. Results are the same whether covariates are omitted or included.

Table 15. Effect of Trier Social Stress Test condition and Resistance to Peer Influence on Self-Conscious Emotions					
	β	T	ΔR^2	F	df
Step 1: Covariates			.06	.84	4, 52
Age	-.19	-1.31			
Race (0 = nonwhite, 1 = white)	.07	0.48			
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.17	-1.23			
Self-Conscious Emotions Before TSST	.17	1.17			
Step 2: Main effects			.12	1.79†	6, 50
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.31	-2.12*			
Resistance to Peer Influence	-.24	-1.66†			
Step 3: Interactive effects			.00	1.53	7, 49
TSST Condition x Resistance to Peer Influence	.46	.39			
Notes: Dependent variable = Self-conscious emotions after TSST. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted. † $p < .10$ * $p < .05$ ** $p < .01$					

Research Question 9

How do salivary cortisol and salivary alpha amylase, together, influence adolescent risk-taking?

To address the ninth research question regarding the potential interactive effect of cortisol and alpha-amylase on risky decision-making, stepwise multiple regression analysis was conducted. Two models were presented with the dependent variable being risky decision-making for both. In the first step of both models, covariates included adolescents' age, race (dummy

coded white), parental education (dummy coded graduate/professional degree), TSST condition, and history of prior risky behavior. In the second step for both models, the main effects of cortisol and alpha-amylase were entered. In the third step for both models, the interaction between cortisol and alpha-amylase was entered. For model 1, cortisol and alpha-amylase delta peak indices were used. For model 2, cortisol and alpha-amylase AUC_{Ground} indices were used.

Table 16 and 17 present the stepwise multiple linear regression conducted to examine whether salivary cortisol and salivary alpha amylase, together, influence adolescent risk-taking. Analyses revealed no significant interactive effect of cortisol and alpha-amylase on risky decision-making. Results are the same whether covariates are omitted or included.

Table 16. Risky Decision-Making Regressed on Interaction Between Cortisol and Alpha-Amylase Delta Peak

Model 1					
	β	t	ΔR^2	F	df
Step 1: Covariates			.01	.14	5, 51
Age	.02	.18			
Race (0 = nonwhite, 1 = white)	-.02	-.13			
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.04	-.23			
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.08	-.50			
History of Risky Behaviors	.06	.42			
Step 2: Main effects			.00	.11	7, 43
Cortisol Delta Peak	.01	.08			
Alpha-Amylase Delta Peak	.01	.06			
Step 3: Interactive effect			.00	.10	8, 42
Cortisol x Alpha-Amylase Delta Peak	.06	.26			
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					
† $p < .10$					
* $p < .05$					
** $p < .01$					

Table 17. Risky Decision-Making Regressed on Interaction Between Cortisol and Alpha-Amylase AUC _{Ground}					
Model 2					
	β	t	ΔR^2	F	df
Step 1: Covariates			.01	.14	5, 51
Age	.02	.18			
Race (0 = nonwhite, 1 = white)	-.02	-.13			
Parental Education (0 = less than a graduate degree, 1 = at least a graduate degree)	-.04	-.23			
TSST Condition (0 = adult-evaluator, 1 = peer-evaluator)	-.08	-.50			
History of Risky Behaviors	.06	.42			
Step 2: Main effects			.05	.41	7, 43
Cortisol AUC _{Ground}	-.18	-1.11			
Alpha-Amylase AUC _{Ground}	-.12	-.79			
Step 3: Interactive effect			.02	.49	8, 42
Cortisol x Alpha-Amylase AUC _{Ground}	-.47	-1.02			
Notes: Dependent variable = Risky decision-making. TSST = Trier Social Stress Test. Results are the same whether covariates are included or omitted.					
† $p < .10$					
* $p < .05$					
** $p < .01$					

V. Discussion

The current dissertation aimed to identify a biological mechanism in the stress response system that could help explain why adolescents are more prone to risky decision-making in social contexts. Results indicated that adolescents who felt more self-conscious also experienced larger increases in salivary alpha-amylase after the TSST. Additionally, there was evidence that self-consciousness varied depending on the age of the TSST evaluators. While it was hypothesized that adolescents in the peer-evaluator condition would feel more self-conscious than adolescents in the adult-evaluator condition, results suggest the opposite. Adolescents who were evaluated by same aged peers reported feeling less self-conscious after the TSST compared to adolescents who were evaluated by adults. This finding remained even after considering the level of self-consciousness adolescents felt before the TSST. In sum, adolescents experienced more self-conscious emotions after of being evaluated by adults and this was related to larger increases in salivary alpha-amylase.

While the findings above suggest an important emotional response to the TSST, the remaining study hypotheses were not confirmed. Specifically, adolescents who experienced social evaluation from same aged peers did not engage in more risky decision making compared to adolescents who experienced social evaluation from adults. There was also no evidence that adolescents' physiological stress response depended on the age of evaluators. While there was evidence that adolescents who were more self-conscious also experienced more of an increase in salivary alpha-amylase (as measured by delta peak index), there was no such evidence that self-consciousness was related to any other indices of physiological stress--overall salivary alpha-amylase (as measured by area under the curve in reference to ground index, AUC_{Ground}), increases in cortisol (as measured by delta peak), and overall salivary cortisol (as measured by

AUC_{Ground}). In addition, self-consciousness was unrelated to risky decision-making—adolescents who were more self-conscious did not engage in riskier decision making. Additionally, adolescents who had a history of being victimized by peers did not feel more self-conscious after the TSST, and adolescents' resistance to peer influence did not buffer self-conscious emotions. Finally, physiological stress was unrelated to adolescents' risky decision-making.

Limitations and Potential Explanations for Null Findings

Before turning attention to significant findings, it is important to present potential explanations for null findings. One of the most important explanations for the current dissertation's null findings is power. Post-hoc power analyses were conducted using the program G*Power (Erdfeiler, Faul, & Buchner, 1996) to establish whether the present design yielded enough power to detect small effects. In all cases of non-significant findings, power analyses revealed the study was underpowered to detect small effects due to limited sample size ($N = 60$) at the recommended .80 level (Cohen, 1965). Indeed, all effects that were observed were small; to detect said small effects, adequate power would require the sample to be increased by upwards of 1,000 adolescents. As such it is impossible to know if the null results observed are because there truly is no effect or because the study did not have sufficient power to detect effects (Onwuegbuzie & Leech, 2004). It is therefore important to refrain from drawing strong conclusions based on the current null findings.

In addition to concerns with power, other factors related to the methodology and design of the current study may have contributed to the null findings. One potential explanation for why there were no observed differences in physiological stress response between adolescents in the peer-evaluator and adult-evaluator conditions could have been due to the use of the social stressor- the Trier Social Stress Test (TSST). It is important to note that the TSST was invented

to induce large, observable stress responses (Kirschbaum, Pirke, & Hellhammer 1993). As such, the TSST may have been “too strong” of a social stressor to address the current research questions. Additionally, the TSST is a very specific type of social stressor—one that elicits social evaluative threat or the experience of being negatively judged. It is possible that using a different type of social stressor may have resulted in more observed differences between conditions. For example, the Yale Interpersonal Stressor (YIPS) is a stressor that involves a participant interacting with and made to feel excluded by two same-sex confederates (Stroud, Tanofsky-Kraff, Wilfley, Salovey, 2000). The YIPS has reliably been used with adolescents and has been shown to have a different effect on stress physiology compared to a performance task similar to the TSST (Stroud, Foster, Papandonatos, Handwerker, Granger, Kivlighan & Niaura, 2009). Specifically, adolescents experienced larger cortisol reactivity in response to the performance task compared to the peer rejections task. Conversely, adolescents experienced larger alpha-amylase reactivity in response to the peer rejection task. These findings illustrate that the type of social stressor likely has differential effects on physiological stress response. Even further, the magnitude of adolescents’ stress response may be calibrated to the type of social stress experienced. As such, although the current study did not detect a difference between stressor conditions, the use of a different type of stressor may have allowed for such a detection.

One potential explanation for why there were no observed differences in risky decision-making was that evaluators were not present (i.e., in the room) when adolescents completed the Stoplight Task. Recent work has identified a distinction between the effects of peer *observation* and peer *influence* on risky decision-making (Centifanti et al., 2014; Haddad, Harrison, Norman, & Lau, 2014). While peer observation involves the mere presence of a peer, peer influence involves a peer instructing or encouraging an adolescent to behave in riskier ways. Specifically,

Centifanti and colleagues (2016) found that compared to peers who were merely present during a risky driving task, peers who were actively providing poor decision-making guidance were more influential in increasing adolescents' risky decision. In the current study design, the adolescent and adult evaluators gave no active instruction to adolescents regarding the decision-making task. Further, evaluators were not present when adolescents completed the risky decision-making task. One of two tentative conclusions can be made. The first is that counter to evidence that adolescents may feel that they are being watched or evaluated when they are not (Elkind & Bowen, 1979), a past evaluative encounter (i.e. having just been evaluated by a peer or an adult but no longer being in their presence) might not have lingering effects on adolescent risky decision-making. A second tentative conclusion is that recent evaluative encounters do indeed influence risky decision-making, but this influence is not subject to the age of evaluators. That is, the risky decisions of adolescents in both the peer-evaluator and adult-evaluator conditions were influenced by evaluation to the same degree and therefore, no difference was found. To better understand if risky decision-making is affected by recent, past evaluative encounters, additional work with a control condition (no past evaluative encounter) is required. While this was not a main aim of the study, it is an important consideration to better understanding the non-significant difference in risky decision-making between conditions.

In addition, the non-significant association between physiological stress and risky decision-making may have been due to the instrument used to measure risky decision-making, the Stoplight Task. The Stoplight Task is widely used and has been correlated with several factors that represent adolescent risky decision-making such as self-reported health risk behaviors (Kim-Spoon et al., 2016), self-reported risk-taking behaviors and impulsivity (Reilly, Greenwald, & Johanson, 2010), and even real-world driving behaviors (Brown et al., 2016).

Further, it has been demonstrated that adolescents' performance on the task is influenced by both older (e.g. Telzer, Ichien, & Qu, 2015) and similarly-aged (Gardner & Steinberg, 2005) observers. Nonetheless, a multitude of cognitive processes (which are also influenced by social factors) lead to risky behaviors. Risky decision-making has thus been segmented into different cognitive tasks such as appraisal of choices, comprehension of the relative costs and benefits of each choice, followed by a reasoned decision (Furby & Beyth-Marom, 1992). Specifically, past research has shown that perceptions of risk—appraisal of how risky a choice may be or how at risk one is to experience an event, is altered when under stress. Jamieson and Mendes (2016) provided empirical evidence of this. Participants in 3 age groups--adolescents (15–19), young adults (25–40), and older adults (60–75)--were randomly assigned to either experience a social stressor or be in a control group. Following, participants were given a measure of risk perception where they were asked to provide ratings on how at risk they were to experience certain life events. Adolescents who were stressed felt that they were less at risk of experiencing negative life events compared to adolescents who were not stressed—stress affected risky choices by altering adolescents' perceptions of how vulnerable they were. Future work may benefit from targeting more than one component of risky decision-making when examining adolescents' choices under stress; past research has illustrated that a good candidate is risk perception.

Another limiting factor in the current design that may have contributed to the non-significant association between physiological stress and risky decision-making is the timing of when adolescents completed the Stoplight Task. In the current design, the Stoplight Task was completed 5 minutes after the Trier Social Stress Test. While salivary alpha-amylase reactivity peaks during this time, cortisol is more slow-responding and does not peak until 20 minutes following an acute stressor (Granger, Kivlighan, El-Sheikh, et al., 2007; Kudielka et al., 2007).

Indeed, the results of this study reflect these different trajectories in cortisol and alpha amylase reactivity patterns. Previous work has provided some evidence that performance on behavioral measures of decision-making is related to the timing of when it is taken in relation to the experience of an acute stressor (Pabst, Brand & Wolf, 2013; Pabst, Schoofs, Pawlikowski, Brand & Wolf, 2013; Starcke, Wolf, Markowitsch & Brand, 2008). Pabst and colleagues (2013) randomly assigned participants to complete a measure of risky decision either immediately after or 10 minutes after an acute laboratory stressor. Participants who completed the measure of risky decision-making 10 minutes after the acute stressor made significantly riskier decisions than participants who completed the measure immediately after the stressor. It was hypothesized that this difference in risky decision-making was due to salivary cortisol's slower response to stress; it took some time for physiological stress to affect risky decisions. Although the effect of stress on behaviors is not completely dependent on the timing and tempo of cortisol release (Starcke & Brand, 2012), it may be important that future work measure risky decision-making closer to when cortisol response to an acute stressor peaks.

While this may explain the null association between cortisol (a marker of hypothalamus-pituitary-adrenal, HPA, axis activity) and risky decision-making, it does not explain the null association between alpha-amylase (a marker of sympathetic nervous system, SNS, activity) and risky decision-making; in the current study, the risky decision-making task was completed when alpha-amylase peaked. If there were an effect of alpha-amylase on risky decision-making in the hypothesized direction (increases in alpha-amylase would be associated with riskier decision-making), then the current design is appropriate. Nonetheless, we find no such association. This further emphasizes the notion that the HPA axis and the SNS are two major systems that work in coordination to generate physiological stress response, but, the exact nature of this coordination

remains unclear. In the current study, while the timing of the risky decision-making task may help us understand the null association between cortisol and risky decision-making, it is likely not an explanation for the null association between alpha-amylase and risky decision-making. If the null association between alpha-amylase and risky decision-making is truly due to the lack of an effect (as opposed to the current study's inadequate sample size), then it is possible that SNS activity (as measured by salivary alpha-amylase) is simply unrelated to risky decision-making (as measured by the Stoplight Task). Or, at the very least, SNS activity is related to risky decision-making in a way that is distinct from how HPA activity is related to risky decision-making.

While the previously described limitations of the current dissertation may offer explanations for null findings, the use of an all-male sample severely limits the study's generalizability. There is good evidence that, at least among adults, male and females' physiological responses to the TSST are different—a recent meta-analysis using 34 studies found that men tend to have higher cortisol values compared to women (Liu et al., 2017). Additionally, there is evidence that the effect of social stress on risky decision-making may be moderated by gender such that men take more risks when stressed and women take fewer (Lighthall et al., 2012; R. van den Bos et al., 2009). As such, it is likely that female adolescents may both respond differently to the TSST and subsequently behave differently on measures of risky decision-making compared to male adolescents. Future work should consider the importance of gender and the potential differences that may arise between male and female adolescents.

In combination, several lessons can be learned from the current null findings. Importantly, the current study was underpowered and therefore it is impossible to know whether null findings would remain if a larger sample were used. Nonetheless and as discussed, several methodological changes could have improved study design, thus allowing for observations of

significant findings. In sum, these include using a more subtle social stressor such as the Yale Interpersonal Stressor, making the effect of evaluation more salient (e.g. having peers and adults present) when risky decision-making is measured, measuring not just risky decision-making but also risk perception, and paying careful attention to the timing of risky decision-making tasks.

Implications of Significant Findings

While there was little evidence for most hypotheses (possibly due to limited statistical power and/or other methodological limitations discussed), the two significant findings in the current study can contribute to the current literature. First, and unexpectedly, adolescents who were evaluated by adults felt more self-conscious compared to adolescents who were evaluated by peers. It was hypothesized that adolescents would care more about what their peers thought of them and therefore evaluation from other adolescents would make them more self-conscious. The opposite, however, was found; adolescents experience more self-conscious emotions after evaluation from adults. One explanation for this counterintuitive finding is that the evaluative setting in the current experiment may have made it appear that intelligence was under evaluation. For the Trier Social Stress Test (TSST), adolescents were asked to come to a University campus and perform (e.g. do arithmetic) in front of people wearing University shirts. It is conceivable that adolescents thought adults were affiliated with the University and that their intelligence was under investigation. Previous work shows that social evaluative situations elicit especially strong reactions when evaluators are perceived to be an authority or an expert on what they are evaluating (Dickerson et al., 2004; Dickerson & Kemeny, 2004). Adolescents may have cared more about what adults affiliated with a University thought about their intelligence because adults affiliated with a University (e.g. professors) may have more expertise and authority in evaluating intelligence. Future studies should examine changes in self-consciousness in different

types of evaluative encounters to see if the current findings are specific to the TSST. One context that may be relevant to study is the school context in which teachers consistently evaluate students' performance and intelligence. While self-consciousness was not found to be related to risky decision-making in the current study, it has been found to be related to academic performance (Beck, Koons, & Milgrim, 2000; Spencer, Steele, & Quinn, 1999); students who feel more self-conscious in school settings perform worse academically. As such, a fairly direct mechanism for intervention may be to create school environments, especially via interactions with teachers that reduce students' self-conscious emotions. Perhaps reducing teachers' evaluative tone (e.g. negative feedback) and increasing supportive social exchanges (e.g. positive feedback) could help students achieve better academic outcomes. This proposition is also supported by work that shows that adolescents respond more to reward than punishment (Cauffman et al., 2010). An important and related consideration relevant to the current findings is research on adolescent brain development. It is well established that adolescent brain development plays a major role in adolescent risky decision-making. Two brain regions have been implicated and studied in relation to adolescent risk-taking. The first, often referred to as the incentive processing system largely focuses on dopamine-rich neural regions such as the ventral striatum which biases decision-making based on prediction of potential rewards (Van Leijenhorst, 2010). The second, referred to the cognitive control system largely focuses on the prefrontal cortex which is critical for higher cognition such as unbiased judgement. Importantly, neuroimaging studies have shown that these brain regions are sensitive to conditions of acute and chronic stress (Galvan & Rahdar, 2013). Stress has been found to increase activity in the incentive processing system and decrease activity in the cognitive control system among adults (Pruessner, Champagne, Meaney & Dagher, 2004; Pruessner, et al., 2008). While similar studies

on adolescents are limited (Galvan & Rahdar, 2013), it is plausible that stress may affect decision-making through its effect on brain functioning, heightening adolescents' reward sensitivity further.

A second significant finding in the current dissertation was that adolescents who felt more self-conscious following the TSST also exhibited stronger increases in alpha-amylase (as measured by delta peak values). This is in line with previous work that has found that both negative emotional arousal (Byrd-Craven, Granger, & Auer, 2011) and positive emotional arousal (Doane & Van Lenten, 2014; Nater et al., 2007), are related to increases in alpha-amylase. As such, the current finding that self-conscious affect is related to increases in alpha-amylase provides additional support for Adam and colleagues' (2011) hypothesis; alpha-amylase production is likely related to emotional arousal, regardless of valence.

The current evidence that elevation in alpha-amylase is related to self-conscious affect raises several interesting empirical questions that may be worth pursuing. First, it is important to note that adolescents are still developing skills to regulate their emotions (Dahl & Gunnar, 2009) and this includes the ability to regulate self-conscious emotions. There is consistent evidence that adolescents feel more self-conscious and are more aware of and concerned about others' opinions; self-consciousness appears to peak during adolescence (Elkind & Bowen, 1979; Rankin, Lane, Gibbons, & Gerrard, 2004; Somerville et al., 2013; Vartanian, 2000). The current findings confirm that, at least in a laboratory setting, self-consciousness is related to increases in alpha-amylase, suggesting that the heightened self-consciousness experienced outside of the laboratory in the daily lives of adolescence may consistently affect sympathetic nervous system activity. The consequences of consistent influences on sympathetic nervous system activity is eloquently depicted by Doane and Van Lenten (2014). In their work, they examined the relation

between emotion and daily alpha-amylase activity in a naturalistic setting. One finding of relevance was that alpha-amylase activity experienced on one day may affect alpha-amylase activity the following day. More specifically, greater amylase in response to negative emotional experiences on one day resulted in less alpha-amylase activity the following day. Authors hypothesized that this lowered alpha-amylase activity following a day of high negative affect and arousal was physiologically adaptive; upon awakening, adolescents' alpha-amylase levels decreased to a lower "set point" in preparation for another demanding, emotional day. If alpha-amylase production increases when adolescents' feel self-conscious, it is possible that prolonged and consistent self-consciousness throughout adolescence may have lasting effects on adolescents' physiological stress response, potentially reducing sympathetic nervous system activity. This may be problematic due to evidence that reduced stress response may be related to externalizing and delinquent behaviors (Klimes-Dougan et al., 2001; McBurnett, Lahey, Rathouz, & Loeber, 2000; Raine, 2005; Shirtcliff et al., 2005; Shoal, Giancola, & Kirillova, 2003). As such, reducing adolescents' experiences of self-consciousness may have far-reaching benefits for physiological health. This, of course, would have to be tested. Doing so would first require establishing that adolescents' self-consciousness outside of the laboratory is related to alpha-amylase activity, that, similar to findings of Doane and colleagues (2014), one day of heightened self-consciousness could lead to dampened alpha-amylase activity on the following day, and that if sustained, this dampened activity could lead to problematic behaviors such as delinquency. Future studies may consider testing these relations to determine if reducing adolescents' experiences of self-consciousness does indeed have far-reaching benefits for physiological functioning and behavioral outcomes. This could lead to a better understanding of

the interplay between biological and social factors across development that make adolescents vulnerable to problem behaviors.

Conclusions

While many of the findings of this study were non-significant, it is important to note that adolescents' felt more self-conscious after adult evaluation than after peer evaluation. This has important implications for the many contexts that adolescents engage. For example, as noted previously, school environments may benefit from better assessing not only students' interactions with peers, but their interactions with teachers. More specifically, highly evaluative interactions with teachers may potential impact students' emotional wellbeing in ways that result in poor academic performance. In addition, while the current study did not provide evidence that self-consciousness was related to risky decision-making, youth in the justice system who are under constant negative evaluation by adults could be more at risk. If negative evaluation elevates alpha-amylase in naturalistic settings such as courtrooms or juvenile detention facilities, the consequences of consistent and constant negative evaluation from adult figures could have long-lasting effects on adolescents' emotional and physiological functioning. Perhaps the most important lesson to be learned from the current study is that adults' negative evaluations are powerful and can potentially affect adolescents' emotional experiences and physiology. Although adolescence is a time of social orientation towards peers, the results of the current study illustrate that adolescents still care about what adults think of them. Future work that attends to the power of negative adult evaluation could shed light on its longer-term effects. Perhaps doing so could identify alternative ways that adults can engage with adolescents in which emotional and physiological functioning would not be compromised.

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Appendix A: Institutional Review Board-Approved Documents

Flyer for Recruitment

A PAID RESEARCH STUDY FROM THE UNIVERSITY OF CALIFORNIA, IRVINE

- WHO ARE WE?
 - UCI researchers conducting a paid study on teenagers' lives
- WHO IS ELIGIBLE TO PARTICIPATE?
 - 12 to 16 year olds who meet a couple other requirements
 - Contact us ASAP to see if you're eligible (space is limited!)
- WHAT WILL YOU NEED TO DO?
 - Meet with one of our researchers for 1-2 hours now on UC Irvine's campus
 - Answer questions about your thoughts, experiences, & behaviors.
 - You will be paid for your time.
- HOW DO I GET INVOLVED?
 - Give us a call or send us an email. We'd love to speak with you!
- CONTACT INFORMATION:
 - Sachiko Donley
 - **(323) 252-8689**
 - donleys@uci.edu



Peer Locator Sheet

Peer Locator Sheet and Consent to Contact

We would like to contact any friends that you might have that would be interested in getting paid to participate in this study. If you think this is something your friends might want to do, would you provide some information so we can contact them?

Name	Age	Address	Phone Number

Consent to Contact

I hereby give the Adolescents and their Peers research staff permission to contact the people listed above.

You can change your mind at any time if you decide that you no longer want us to contact these people. Participation will be entirely voluntary and your friends do not have to participate. We will not tell your friends anything about your involvement with the Adolescents and their Peers study, other than you gave us their name. Also, only friends who meet our eligibility requirements will be able to participate in the study.

Signature of subject

Date

Printed name of subject

Witness

Parental Consent Form

UNIVERSITY OF CALIFORNIA, IRVINE PARENTAL CONSENT TO ACT AS A HUMAN RESEARCH SUBJECT

Study Title: Adolescents and Their Peers

You are being asked to provide consent for your child to participate in a research study. Participation is completely voluntary. Please read the information below and ask questions about anything that you do not understand before deciding if you want your child to participate. A researcher listed below will be available to answer your questions.

RESEARCH TEAM

Lead Researcher

Sachiko Donley, Graduate Student
Psychology and Social Behavior
323-252-8689 / donleys@uci.edu

Faculty Sponsor

Dr. Elizabeth Cauffman, Professor
Psychology and Social Behavior
949-824-4075 / cauffman@uci.edu

WHY IS THIS RESEARCH STUDY BEING DONE?

The purpose of this research study is to understand why teenagers so easily cave to peer pressure and sometimes make bad decisions in the presence of their peers.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

This study will enroll approximately 200 participants. All study procedures will be done at the University of California, Irvine's campus.

WHAT PROCEDURES ARE INVOLVED WITH THIS STUDY AND HOW LONG WILL THEY TAKE?

1. First, your child will enter a room with a computer. He will be asked to use the computer to answer a number of questions about his background and psychological state (25 minutes). Then, he will be asked to go to a different room to prepare a speech that he will deliver to a panel of judges. This should take about 15 minutes and will be video recorded. Following this speech, your child will play a 15-minute computerized driving game followed by a series of questions on the computer (15 minutes worth of questions). Throughout this process, we will ask your child to provide saliva samples to us so that we can understand the levels of his stress hormones. In total we will ask for 4 saliva samples.
2. Participation in the study will include 1 visit and take a total of about 1.5 to 2 hours.

Your child must meet the following requirements to be in the study:

- male;
- ages 12 - 16
- fluent in English
- have no serious mental health problems
- not taking any prescription medication
- does not smoke cigarettes.

WHAT ARE THE POSSIBLE DISCOMFORTS OR RISKS RELATED TO THE STUDY?

There are no known harms or discomforts associated with this study beyond those encountered in normal daily life. The possible risks and/or discomforts associated with the procedures described in this study include: feeling distressed by the questions or by the interview and a potential for a breach of confidentiality.

ARE THERE BENEFITS TO TAKING PART IN THE STUDY?

Participant Benefits

Your child will not directly benefit from participation in this study.

Benefits to Others or Society

Your child's participation in this study can better our understanding of why teenagers make bad decisions in the presence of their peers and how their stress response to their peers can help explain this phenomenon.

WILL MY CHILD BE PAID FOR TAKING PART IN THIS STUDY?

Compensation

Your child will receive \$25.00 for his participation in this study. Your child will not be reimbursed for any out of pocket expenses, such as parking or transportation fees.

WHAT HAPPENS IF MY CHILD IS INJURED BECAUSE I TOOK PART IN THIS STUDY?

It is important that your child promptly tell the researchers if he believes that he has been injured because of taking part in this study. He can tell the researcher in person or call him/her at the number listed at the top of this form.

If your child is injured as a result of being in this study, UCI will provide necessary medical treatment. The costs of the treatment may be covered by the University of California or the study sponsor, or billed to you or your insurer just like other medical costs, depending on a number of factors. The University and the study sponsor do not normally provide any other form of compensation for injury. For more information about this, you may call the UCI Human Research Protections unit at (949) 824-6662 or by e-mail at IRB@research.uci.edu

WHAT HAPPENS IF MY CHILD WANTS TO STOP TAKING PART IN THIS STUDY?

Your child is free to withdraw from this study at any time. **If your child decides to withdraw from this study he should notify the research team immediately.** The research team may also end his participation in this study if he does not follow instructions, misses scheduled visits, or if his safety and welfare are at risk.

If your child withdraws or is removed from the study, the researcher may ask your child to return at another convenient time to attempt to complete participation in the study.

If you elect to withdraw or are withdrawn from this research study, the researchers will discuss with you what they intend to do with your study data. Researchers may choose to analyze the study data already collected or they may choose to exclude your data from the analysis of study data and destroy it, as per your request.

HOW WILL MY CHILD'S PERSONAL INFORMATION BE KEPT?

Subject Identifiable Data

All identifiable information collected about your child will be removed and replaced with a code. A list linking the code and your identifiable information will be kept separate from the research data.

Data Storage

Research data will be maintained in a secure location at UCI. Only authorized individuals will have access to it. Research data will be stored electronically on a secure network in an encrypted file with password protection.

The [audio/video recordings] will also be stored in a secure location and transcribed. The recordings will be retained with the other research data.

Data Retention

The researchers intend to keep the research data, including identifiable video footage, in a repository indefinitely. Other researchers may have access to the data for future research.

WHO WILL HAVE ACCESS TO MY CHILD'S STUDY DATA?

The research team, authorized UCI personnel, and regulatory entities such as the Office of Human Research Protections (OHRP), may have access to your child's study records to protect your child's safety and welfare.

Any information derived from this research project that personally identifies your child will not be voluntarily released or disclosed by these entities without your separate consent, except as specifically required by law. Study records provided to authorized, non-UCI entities will not contain identifiable information about your child; nor will any publications and/or presentations without your separate consent.

While the research team will make every effort to keep your personal information confidential, it is possible that an unauthorized person might see it. We cannot guarantee total privacy

WHO CAN ANSWER MY OR MY CHILD'S QUESTIONS ABOUT THE STUDY?

If you have any comments, concerns, or questions regarding the conduct of this research, please contact the research team listed at the top of this form.

Please contact UCI's Office of Research by phone, (949) 824-6662, by e-mail at IRB@research.uci.edu or at 5171 California Avenue, Suite 150, Irvine, CA 92697, if you are unable to reach the researchers listed at the top of the form and have general questions; have concerns or complaints about the research; have questions about your rights as a research subject; or have general comments or suggestions.

HOW DO I AGREE TO ALLOW MY CHILD TO PARTICIPATE IN THIS STUDY?

You should not sign this consent form until all of your questions about this study have been answered by a member of the research team listed at the top of this form. You will be given a copy of this consent form to keep. **Your child's participation in this study is voluntary.** He may refuse to answer any question or discontinue his involvement at any time without penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect your or your child's future relationship with UCI or your or your child's quality of care at the UCI Medical Center.

_____ Yes, I agree to allow the research team to video record my child's interview.

_____ No, I do not agree to allow the research team to audio record my child's interview.

Your signature below indicates you have read the information in this consent form and have had a chance to ask any questions you have about this study.

I agree to allow my child to participate in the study.

Printed Name of Subject

Parent/ Legal Guardian Signature

Date

Printed Name of Parent / Legal Guardian

Relationship to Subject

Researcher Signature

Date

Printed Name of Researcher

Study Information Sheet for Verbal Assent

University of California, Irvine Study Information Sheet

Study Title: Adolescents and Their Peers

Lead Researcher

Sachiko Donley, Graduate Student
Psychology and Social Behavior
323-252-8689
donleys@uci.edu

Faculty Sponsor

Dr. Elizabeth Cauffman, Professor
Psychology and Social Behavior
949-824-4075
cauffman@uci.edu

- You are being asked to participate in a research study to understand how teenagers react to new events.
- You are eligible to participate in this study if you identify as male; are between the ages of 12 and 16; are fluent in English; have no serious mental health problems; are not taking any prescription medication; do not smoke cigarettes.
- The research procedures involve answering questions about yourself on a computer, a video-taped interview that will last approximately 10 minutes, and the collection of 4 samples of your spit. All of this will take place at the University of California- Irvine. In total, this will take about 1.5 to 2 hours of your time.
- Possible risks/discomforts associated with the study are feeling distressed by the questions or by the interview; a potential for a breach of confidentiality.
- There are no direct benefits from participation in the study. However, this study may explain why teenagers care about what their friends think of them.
- You will receive \$25.00 for your participation in this study.
- All research data collected will be stored securely and confidentially in a locked cabinet. Your name will not be attached to any of your answers or spit samples instead we will use a number. Your videotaped interviews will always be kept in a locked closet and once we are done analyzing them will be securely destroyed.
- The research team, authorized UCI personnel, and regulatory entities may have access to your study records to protect your safety and welfare. Any information derived from this research project that personally identifies you will not be voluntarily released or disclosed by these entities without your separate consent, except as specifically required by law.
- If you have any comments, concerns, or questions regarding the conduct of this research please contact the researchers listed at the top of this form.
- Please contact UCI's Office of Research by phone, (949) 824-6662, by e-mail at IRB@research.uci.edu or at 5171 California Avenue, Suite 150, Irvine, CA 92697 if you are unable to

reach the researchers listed at the top of the form and have general questions; have concerns or complaints about the research; have questions about your rights as a research subject; or have general comments or suggestions.

- Participation in this study is voluntary. There is no cost to you for participating. You may choose to skip a question or a study procedure. You may refuse to participate or discontinue your involvement at any time without penalty. You are free to withdraw from this study at any time. **If you decide to withdraw from this study you should notify the research team immediately.**

Script for Trier Social Stress Test Evaluators

Evaluators' Script for the Trier Social Stress Test

BEFORE THE PARTICIPANT ENTERS THE ROOM

REMINDER: Evaluators should always keep quiet, even if participant is not present in the room

- Turn on the Video Camera
 - Flip Open the viewing panel on the left side of the camera (this is the flat screen where you can see what the camera is focusing on)
 - Swivel it upwards so that you can see the screen
 - Hit the START/STOP button to start recording (“REC” in red on should be the screen)
 - Read the following into the camera before EACH participant comes in:
 - “Today’s date is **[say today’s date]**.”
 - “Evaluators are **[each evaluator says his/her name]**.”
 - “Subject is **[say the subject ID that will be written on the paper on your desk]**.”
 - Hit the START/STOP button to **STOP** recording (“STBY” in green should be on the screen)

AFTER THE PARTICIPANT ENTERS THE ROOM

NOTE: If you see participant is not standing behind the line, remind them by saying “Please stand behind the line”

LEADER READ TO THE PARTICIPANT: *“During this portion of today’s session, you will be asked to tell us about yourself for 5 minutes. During these 5-minutes, introduce yourself and tell*

us about yourself so that we can get to know you and determine if we like you or not. You can tell us your name, talk about your family, your hobbies, your friends, your personality, and any siblings or pets you may have. We will videotape what you say so that we can review what you say later. You now have 2 minutes to prepare what you want to say to us. During this time, please think about what you will say as you will not be able to use your notes during your speech. Please have a seat to take notes”

SECOND IN COMMAND START THE STOPWATCH and REMAIN SILENT

AFTER 2 MINUTES...

SECOND IN COMMAND RESET THE STOPWATCH

LEADER READ TO THE PARTICIPANT: *“Your 2 minutes are up. Please stand up.”*

NOTE: Again, if you see participant is not standing behind the line, remind them by saying “Please stand behind the line”

- **Hit the START/STOP button to start recording (“REC” in red should be on the screen) and make sure that the camera is focused on the participant while he gives the speech (you can zoom in and out by turning the knob around the START/STOP button)**

LEADER READ TO THE PARTICIPANT: *“Please start your speech.”*

SECOND IN COMMAND START THE STOPWATCH

NOTE: If the participant does not use the full 5 minutes, remind him that he still has time to talk about himself. You can say, *“Please keep going. Your 5 minutes is not up.”*

AFTER 5 MINUTES...

LEADER READ TO THE PARTICIPANT: *“Your 5 minutes is up. Now you will have to do some math problems. When I say ‘go’ please begin counting backwards from 2,372 by thirteen each time. If you make a mistake you must begin again. Do you have any questions? GO”*

NOTE: If the participant does have questions, re-read the instructions above to him starting from “Now you will have to do some math problems...”

SECOND IN COMMAND RESET THE STOPWATCH

SECOND IN COMMAND START THE STOPWATCH

NOTE: If the participant makes a mistake *STERNLY* READ TO THE PARTICIPANT: *“Wrong! Please begin again and start from 2,372.”*

SECOND IN COMMAND Let the participant do the task for 1 minute.

You can also say things like: *“Please do this task faster,”* or *“You should be further down this list by now.”*

Below are the CORRECT Responses

2372	2307	2242	2177	2112	2047
2359	2294	2229	2164	2099	2034
2346	2281	2216	2151	2086	2021
2333	2268	2203	2138	2073	2008
2320	2255	2190	2125	2060	1995

AFTER 1 MINUTE...

LEADER READ TO THE PARTICIPANT: *“It’s been 1 minute. This portion of the study is over. You may return to the room you were first in.”*

AFTER THE PARTICIPANT LEAVES THE ROOM

- **Hit the START/STOP button to STOP recording (“STBY” in green should be on the screen)**

REMINDER: Evaluators should always keep quiet, even if participant is not present in the room

Appendix B: Funding Sources

American Psychological Foundation



August 3, 2015

Ms. Sachiko Donley
5171 California Avenue
Suite 150
Irvine, CA 92697-7600

Dear Ms. Donley:

It is my pleasure to inform you that you have been selected to receive the 2015 American Psychological Foundation's (APF) Visionary Fund Grant. On behalf of the APF Board of Trustees and staff, I'd like to offer my congratulations.

As the recipient of this grant, you will receive \$19,904. The Foundation will also publish notification of your grant in the *APA Monitor on Psychology*. More information about your grant will arrive shortly under separate cover.

We hope that this grant both assists you with your current work and inspires future endeavors in the field of psychology.

If you have any questions, please contact Samantha Edington, Program Officer, at (202) 336-5984 or sedington@apa.org.

Sincerely,

A handwritten signature in blue ink that reads "Elisabeth R. Straus". The signature is written in a cursive, flowing style.

Elisabeth R. Straus
Executive Vice President/Executive Director

Cc: Linda Levine, PhD

National Institute of Justice

UNIVERSITY OF CALIFORNIA, IRVINE
OFFICE OF RESEARCH ADMINISTRATION

Fund Number: 22669

Account Number: 447586

Award Synopsis

Fund Assign Code:

Federal Code:

Principal Investigator:	CAUFFMAN, ELIZABETH (091072169),	Proposal Number:	204738
Fellow:	SACHIKO DONLEY		
Administrative Dept:	Social Ecology		
Sponsor:	National Institute of Justice		
Award Number:	2016-R2-CX-0009	Synopsis Number:	1
Award Type:	Grant	Sponsor Mod. Number:	
Award Action:	New		
Award Purpose:	Fellowship	Previous Award number:	
Project Title:	You're Stressing Me Out: Adolescent Stress Response to Evaluation from Peers and its Effect on Risky Decision-Making		
Prime Award #:		Prime Sponsor:	
Funds Awarded:			
Direct Costs:	\$30,416.00		
F & A Costs:	\$0.00	at 0	Modified Total Direct Cost
F & A Type:	Class Waiver		
Spon In-Kind cost:			
Total Cost This Action:	\$30,416.00	Cumulative Funds Awarded:	\$30,416.00
Off Campus:	N		
Period of Performance Begins:	10/01/16	Ends:	09/30/17
Budget Period Begins:		Ends:	
		Additional Years Anticipated:	

TERMS AND CONDITIONS

General Provisions governing this award:

NoA: 07/18/2016

2 CFR Part 200 - Uniform Admin Reqs, Cost Principles, and Audit Reqs for Federal Awards (<http://www.ecfr.gov/cgi-bin/text-idx?SID=497824396600241bb80015f182d74989&tpl=/ecfrbrowse/Title02/2chapterII.tpl>) 2 CFR Part 2800

Total Project Cost Sharing Obligations:

	Amt This Action	Total Cumulative Amt
Total Cost Share:	\$0.00	\$0.00

Equipment title vests in:

Standard Reports:

10/30/17 Final Progress

Financial Disclosures:

Special Reports:

01/31/17 Semi-annual Progress Report

07/31/17 Semi-annual Progress Report

SYNOPSIS REMARKS:

Please refer to the Notice of Award for Terms and Conditions and reporting requirements applicable to this award.

ORA Contact Name	Phone	E-Mail
DIAZ, MARIA	(949) 824-3172	mgdiaz1@uci.edu

Process Date: 10/20/16

Print Date/Time: 10/21/16 / 8:22:00AM