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Neurobehavioral Correlates of Familism and Adolescent Risk Taking

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Psychology

by

Eva Haimo Telzer

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ABSTRACT OF THE DISSERTAION

Neurobehavioral Correlates of Familism and Adolescent Risk Taking

by

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Doctor of Philosophy in Psychology

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Professor Andrew Fuligni, Co-Chair

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Risk taking underlies many health problems that contribute to the public health burden during the adolescent period. Recent advances in developmental neuroscience have identified key neurobiological underpinnings of adolescent risk taking, but there is little understanding of how these neural processes interact with social processes in order to promote or prevent risk taking. In this dissertation, I use a multi-method, longitudinal program of research, including daily diaries, experimental tasks, and neuroimaging, to examine the mechanisms by which a culturally meaningful type of family relationship – familism – buffers Mexican youth from drug use and risk taking. Familism is a fundamental aspect of family life, which implies children's role in the support and assistance of their family. Results of Study 1 suggest that family obligation values are protective, relating to dampened substance use, largely due to the links with decreased association with deviant peers and increased disclosure to parents. In contrast, family assistance behaviors are a source of risk within high parent-child conflict homes, relating to higher levels of substance use. In study 2, I examine whether familism is protective by influencing neural regions involved in reward processing and cognitive control, neural processes implicated in adolescent risk taking. Results indicate that family obligation values are associated with reduced ventral striatum (VS) activation when receiving monetary rewards and increased prefrontal cortex (PFC) activation when inhibiting behavioral responses. Reduced VS activation correlates with less real-life risk taking behavior and enhanced PFC activation correlates with better decision-making skills. Thus, family obligation may decrease reward sensitivity and enhance cognitive control, thereby reducing adolescent risk taking. In Study 3, I examine whether the meaningful and rewarding nature of family assistance may be an asset for adolescents. Results show that enhanced VS activation when contributing to the family predicts decreases in adolescents' risk taking behavior over the next year. Thus, family relationships that are personally meaningful can provide adolescents with a sense of reward, and this reward may lead to positive, healthy outcomes. Results of this dissertation indicate that traditional family values and practices play a critical role in shaping Mexican adolescents' risk for substance use and risk taking.

The dissertation of Eva Haimo Telzer is approved

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This dissertation is dedicated in loving memory to my grandmother, Dr. Deborah Haimo, for sharing her love and appreciation of education and for inspiring me to attain a Ph.D.

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Chapter 1

Introduction:

Neurobehavioral Correlates of Familism and Adolescent Risk Taking

Risk taking underlies many behavioral and health problems, such as substance use and externalizing behavior that contribute to the public health burden during the adolescent period. Recent advances in developmental neuroscience have identified key neurobiological underpinnings of adolescent risk taking, but there is little understanding of how these neural processes interact with social processes in order to promote or prevent risk taking. In this dissertation, I use a multi-method, longitudinal program of research, including daily diaries, experimental tasks, and functional magnetic resonance imaging (fMRI), to examine the mechanisms by which a culturally meaningful type of family relationship – familism – buffers Mexican youth from drug use and risk taking.

Risk Taking and Drug Use in Adolescence

Adolescence is a time of heightened propensity for risk-taking, impulsivity, and reckless behavior that often lead to poor decisions such as drug initiation (Arnett, 1992; Chambers et al., 2003; Steinberg, 2008). Adolescent drug use is one of today's most important social concerns as it contributes to a host of serious immediate and long term outcomes such as risky sexual behavior, unwanted pregnancies, morbidity and mortality, violent behavior, and high school drop out (Fergusson et al., 2002; Guy, Smith, & Bentler, 1994; Ramirez et al., 2004; Lancot & Smith, 2001; Kann et al., 1998; Ellickson et al., 1998). These consequences are of particular concern during high school, a critical time for drug use initiation and experimentation. By the time youth reach 12th grade, 47% have tried an illicit drug at least once (Johnston et al., 2009).

Challenges associated with immigration place adolescents from Mexican backgrounds at a greater risk for a variety of adjustment problems including substance use. Compared to other ethnic groups, Latino teenagers begin using drugs at an earlier age, show greater risk for developing drug use disorders in adulthood due to early drug use onset, and have higher overall rates of illicit drug use (Johnston et al., 2009; Ellickson et al., 2004; Gil et al., 2004; Centers for Disease Control, 2005; Vega et al., 1993). In particular, Latinos have the highest rate for the most dangerous drugs, such as heroin, crack, and crystal methamphetamine (Johnston et al., 2009).

Drug use among Latinos is an especially important social concern as Latinos have become the largest ethnic minority group in the United States, comprising 16.3% of the U.S. population, with those from Mexican backgrounds representing 63% of all Latinos in the United States (Ennis, Rios-Vargas, & Albert, 2011). Furthermore, in Los Angeles, California, the site of the current study, Latinos make up 48% of the population, with those from Mexican backgrounds representing 84% of Latinos in Los Angeles (Ennis, Rios-Vargas, & Albert, 2011). Attending to the health of this growing population should be a central concern and seen as an investment in the health of the country (Ojeda et al., 2008). Given the higher rate of drug use among Latinos and the serious consequences of drug use, it is imperative to identify culturally relevant factors that can enhance the development of efforts to reduce drug use among this growing population.

The Neurobiology of Risk Taking during Adolescence

Evidence from developmental neuroscience suggests that risk taking behavior increases during adolescence partly due to changes in the brain's neural circuitry (Casey et al., 2011; Steinberg, 2008). Subcortical regions, which comprise neural regions associated with the evaluation of rewards (e.g., amygdala and ventral striatum (VS)), mature relatively early, leading to increased reward seeking during adolescence. In contrast, cortical regions, which comprise neural regions involved in higher order cognition and impulse control (e.g., ventral and dorsal lateral prefrontal cortices (VLPFC, DLPFC)), gradually mature over adolescence and into adulthood. The relative imbalance in the maturation of these systems (see Figure 1) leaves the adolescent more vulnerable to take risks and less able to modulate social and emotional decisions (Casey et al., 2011; Steinberg, 2008). Immature cognitive control development relative to the reward system may hinder appropriate evaluation of risk and bias youth towards risky decisions.

Several fMRI studies examining neural sensitivity to reward have found that ventral striatum activation, a region sensitive to rewarding stimuli, shows enhanced activation in adolescents compared to both children and adults, whereas the lateral prefrontal cortex, a region involved in cognitive control, shows increasingly more focal recruitment with development (Galvan et al., 2006; Ernst et al., 2005; Eshel et al., 2007). Enhanced VS activation and reduced PFC activation correlate with more risky behavior (Galvan et al., 2007; Ernst et al., 2005), suggesting that reduced cognitive control coupled with increased sensitivity to reward may partly underlie adolescent risk taking.

The dual systems model of neurobiological development offers a promising way to view the maturational underpinnings of risk taking during the teenage years. Yet, risk taking does not occur in a social vacuum, and it is critical to examine how these neural mechanisms interact with fundamental social processes during adolescence. The changing nature of family relationships during the adolescent years is a basic developmental and social process that can have significant implications for risk taking and associated health consequences, such as substance use and externalizing problems (Gfroerer & de la Rosa, 1993; Warner et al., 2006). This dissertation examines how familism, a key aspect of family relationships for adolescents from Mexican backgrounds, may alter the neurobiology of risk taking.

Familism and the Neurobiology of Risk Taking during Adolescence

The emphasis upon the role of children and adolescents to support, assist, and take into account the needs and wishes of the family is perhaps the most distinctive aspect of family relationships among families with Mexican backgrounds in the United States. This type of family connection, often called “familism” or “family obligation,” exists within Mexican and other Latin American families (Suárez-Orozco & Suárez-Orozco, 1995). Youth from these families stress the importance of spending time with the family, high family unity, family social support, and interdependence for daily activities (Cuellar et al., 1995; Fuligni, 2001). When families immigrate to the United States, this tradition takes on a very real significance when parents face difficulty finding stable and well-paying employment and are unfamiliar with the norms of American society. Compared to youth from European backgrounds, youth from Mexican backgrounds spend almost twice as much time helping their family each day, and assist their family 5-6 days per week on average, suggesting that family assistance is a meaningful daily routine for these adolescents (Telzer & Fuligni, 2009). Further, young adults from Mexican backgrounds make financial contributions to their families at higher rates than their peers (Fuligni & Pedersen, 2002), and those from second and third generations continue to maintain a strong sense of family obligation (Fuligni, et al., 1999).

Cultural familial values can affect youths’ engagement in risky behavior. The family may be an especially important protective factor for Mexican youth (Gfoerer & de la Rosa, 1993; Warner et al., 2006). Adolescents who internalize the familistic values of their family feel more connected to and embedded within a supportive family network, which can provide them with a sense of support and structure to help them deal with the challenges associated with being a teenager in American society (Hardway & Fuligni, 2006). Perhaps not surprisingly, familism and family pride have been associated with reduced likelihood of using drugs, delayed onset of drug use, and lower rates of externalizing problems among Latino youth (e.g., German et al., 2009; Gil et al., 2000; Kaplan et al., 2001; Ramirez & de la Cruz, 2003).

Significance of This Work

This research will advance our understanding of risk taking among Latinos and the culturally relevant protective factors that can reduce risk for drug initiation among this growing population. Findings will enable us to tease apart how the cognitive control and reward systems relate to familism and real-life risk behaviors, which has the potential to inform the design of successful interventions that can efficiently target these systems to help youth make better, less risky decisions. For instance, if lower levels of familism are associated with deficits in cognitive control, interventions can target the improvement of cognitive control processes by training individuals to engage in behaviors that involve placing other individuals before oneself, making more deliberative decisions in everyday life, and practicing self control. If higher levels of familism are associated with reduced reward sensitivity to risk taking, interventions can promote the maintenance of traditional cultural values in addition to the acquisition of other types of reward in youths' lives, such as positive friendships, after school sports, or prosocial behaviors. In addition to informing policy and intervention, findings from this research will help guide future research to identify other culturally relevant factors that may protect diverse youth from engaging in drug use and risky behavior.

In the following chapters, I present three studies that examine the mechanisms by which familism may buffer Mexican youth from substance use and risk taking behavior. This dissertation brings together several cutting edge bio-behavioral methods including daily diary checklists, experimental behavioral tasks, and neuroimaging. The combination of these techniques allowed me to (a) obtain a close assessment of daily behavior and family relationships as well as the meaning of that behavior in a naturalistic setting, (b) study the underlying neural mechanisms that are associated with family relationships, and (c) link these neural mechanisms to changes in youths' risk taking over time.

Summary of Study 1: <u>Examine the behavioral links between familism and risk taking behaviors.</u> Familism and family pride have been associated with reduced likelihood of using drugs among Latino youth. However, the mechanisms by which familism protects youth from engaging in substance use remain relatively unknown, and no studies to date have examined how actual family assistance behaviors relate to adolescent substance use. In study 1, I extend this research by examining how Mexican adolescents' family obligation values and family assistance behaviors differentially relate to substance use. Results suggest that family obligation values are protective, relating to dampened substance use, largely due to the links with decreased association with deviant peers and increased adolescent disclosure. In contrast, family assistance behaviors are a source of risk within high parent-child conflict homes, relating to higher levels of substance use. This study suggests that cultural values of familism are protective for Mexican adolescents, but the translation of these values into behaviors can be problematic, depending upon the relational context of the family

Summary of Study 2: <u>Examine how familism relates to the neurobiology of adolescent risk taking.</u> The dual systems model of adolescent neurobiological development (see Figure 1), proposes that adolescent risk taking arises, in part, due to the earlier development of subcortical limbic regions relative to the later development of cognitive control prefrontal regions. In study 2, I examine whether familism is protective by influencing these neural regions, increasing cognitive regulation and reducing reward sensitivity, thereby decreasing the neural imbalance present in adolescence. Results indicate that familism is associated with reduced VS activation when receiving monetary rewards and increased prefrontal activation when inhibiting behavioral responses. Reduced VS activation correlates with less real-life risk taking behavior and enhanced PFC activation correlates with better decision making skills. Thus, family obligation may reduce the neural imbalance during adolescence, decreasing reward sensitivity and enhancing cognitive control, and this may reduce adolescent risk taking. Importantly, family obligation predicts neural activation above and beyond the effects of more general family cohesion. Therefore, family obligation represents a unique aspect of family relationships, suggesting that it is not simply about having a close and supportive family that reduces neural sensitivity to risk. Rather, the independent predictive value of family obligation suggests the results are due to specific types of family relationships that foster self-regulatory skills and an avoidance of behaviors that could have negative consequences.

Summary of Study 3: Examine whether the rewarding nature of familism predicts decreases in adolescents' real-life risk taking behaviors. The relatively early development of the socioemotional system has largely been suggested to create vulnerabilities, contributing to the high rate of problem behaviors during adolescence. Little work has examined how heightened reward sensitivity can create opportunities for adolescents. In several prior studies, I have found that family assistance is a rewarding activity and engages the mesolimbic reward system (Telzer & Fuligni, 2009; Telzer et al., 2010). In Study 3, I examine how this enhanced reward activation to family assistance behaviors may be an asset for adolescents. Results show that greater VS activation to family assistance predicts decreases in risk taking behavior over the next year. Thus, family relationships that are personally meaningful for adolescents can provide them with a sense of reward, and this reward may be protective and lead to positive, healthy outcomes. Therefore, the very same neural regions that create vulnerabilities for adolescents may also be protective if engaged in a positive way.

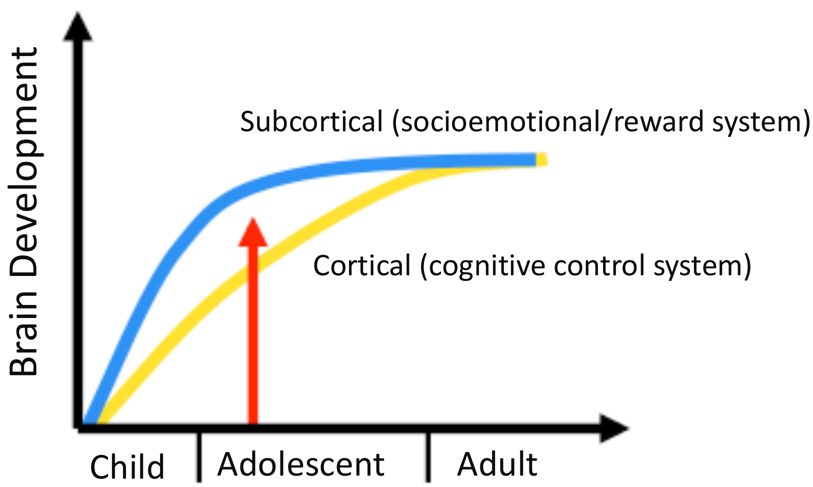
General Procedures

Given the initiation of and steady increase in risk taking behaviors during high school, I examined Mexican youth longitudinally during their high school years. This three year longitudinal project included three waves of data collection. Participants from Study 1 were from a sample of over 400 Mexican youth from the Los Angeles area who participated in a large-scale, longitudinal study examining familism, internalizing and externalizing behaviors, and substance use. In their 9th or 10th grade, participants completed a daily diary across 14 days that measured their family assistance behaviors. In addition, participants completed a questionnaire indicating their family obligation values and lifetime substance use.

In the fall of their 10th or 11th grade, 48 adolescents were recruited from the larger sample to participate in an fMRI study. Adolescents came to the UCLA Center for Cognitive Neuroscience where they underwent a brain scan during which they completed a risk taking and cognitive control task. Following the scan, participants completed several measures indicating their risk taking behavior, decision-making competence, and the likelihood of engaging in risky behavior in the next year.

In the fall of their 11th or 12th grade, all participants who completed the brain scan were contacted by phone and asked to complete an online survey. Forty adolescents agreed to complete the survey. Participants completed several questionnaires, which asked them about their current risk taking behaviors, thus allowing me to examine changes in risk taking behavior over time.

Figure 1.1 Dual Systems Model of Adolescence. Neurobiological model depicting earlier development of subcortical limbic regions (e.g. ventral striatum) relative to later development of cognitive control prefrontal regions. This neural imbalance in development (depicted with the red arrow) is suggested to be at the core of risky decision-making behavior. (adapted from Casey et al., 2011)



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Chapter 2

Family Obligation Values and Family Assistance Behaviors:

Risk and Protective Factors for Adolescent Substance Use

Adolescent substance use is one of today's most important social concerns as it contributes to a host of serious immediate and long term outcomes such as risky sex and HIV infection, morbidity and mortality, psychiatric problems, and a greater risk for high school drop out (Ellickson, Bui, Bell, & McGuigan, 1998; Fergusson, Horwood, & Swain-Campbell, 2002; Guy, Smith, & Bentler, 1994; Lancot & Smith, 2001; Ramirez et al., 2004). These consequences are of particular concern during high school, a critical time for drug use initiation and experimentation. For example, lifetime illicit drug use more than doubles and current drug use (i.e., use within the past 30 days) more than triples between 8th and 12th grade, such that by the 12^{th} grade, nearly half of youth have tried an illicit drug at least once (Johnston, O'Malley, Bachman, & Schulenberg, 2009).

Although Latinos fare better than other ethnic groups on some health outcomes, Latino teenagers begin using drugs at an earlier age, show greater risk for developing drug use disorders in adulthood due to early drug use onset, and have higher overall rates of illicit drug use (Centers for Disease Control and Prevention, 2005; Ellickson, Martino, & Collins, 2004; Gil, Wagner, & Tubman, 2004; Johnston, et al., 2009; Vega, Zimmerman, Warheit, Apospori, & Gil, 1993). In order to address these health disparities, there is great need for systematic research that examines the risk and protective factors for adolescent substance use within cultural contexts (García Coll, Crnic, Lamberty, Wasik, et al., 1996). However, limited research has examined risk and protective factors for substance use among adolescents from Mexican backgrounds.

Substance use among Mexican adolescents is an especially important social concern, as Latinos have become the largest ethnic minority group in the United States, comprising 16.3% of the U.S. population, with those from Mexican backgrounds representing 63% of all Latinos in the United States (Ennis, Rios-Vargas, & Albert, 2011). Furthermore, in Los Angeles, California, the site of the current study, Latinos make up 48% of the population, with those from Mexican backgrounds representing 84% of Latinos in Los Angeles (Ennis, Rios-Vargas, & Albert, 2011). Attending to the health of this growing population should be a central concern and seen as an investment in the health of the country (Ojeda et al., 2008). Recognizing the particular importance of family connection and support for many families from Mexican backgrounds, the current study seeks to examine how familism may be a source of protection or risk for substance use among Mexican adolescents. Two important aspects of familism are family obligation values (i.e., adolescents' sense of responsibility to support and respect their family) and family assistance behaviors (i.e., adolescents' provision of instrumental support to their family).

Family Obligation Values and Family Assistance Behaviors

Families from Mexican backgrounds often have a strong sense of family connection and support, highly valuing time with their family, family unity, family social support, and interdependence for daily activities (García Coll & Vázquez Garcia, 1995; Suárez-Orozco, & Suárez-Orozco, 1995). These values are referred to as family obligation, the psychological sense that one should help, respect, and contribute to the family. Adolescents from Mexican backgrounds place a stronger emphasis on family obligation than do their peers from European backgrounds, suggesting that it is a particularly important aspect of family relationships among immigrant and ethnic minority families (Fuligni, Tseng, & Lam, 1999; Hardway & Fuligni, 2006; Orellana 2001; Suárez-Orozco, & Suárez-Orozco, 1995).

Family obligation values are related to family assistance behaviors, which are the concrete behaviors to help ones family including caring for siblings, cleaning the home, translating for parents, and cooking meals. Adolescents from Mexican backgrounds spend more time assisting their families than do adolescents from European backgrounds (Hardway &

Fuligni, 2006; Telzer & Fuligni, 2009b). Compared to their European peers, youth from Mexican backgrounds spend almost twice as much time helping their family each day and assist their family 5-6 days per week on average (Telzer & Fuligni, 2009a; Telzer & Fuligni, 2009b), suggesting that family assistance is an important daily routine for these families.

Family Obligation Values and Substance Use

Adolescents who internalize the values of their family may feel more connected to and embedded within a supportive family network, which can provide them with a sense of support and structure to help them select effective coping strategies and avoid substance use (Unger et al., 2002). Empirical research suggests that family obligation values serve as a protective factor against substance use. Family obligation values are associated with reduced likelihood of using drugs, delayed onset of drug use, and lower rates of externalizing problems among Latino youth (German, Gonzales, & Dumka, 2009; Gil, Wagner, & Vega, 2000; Kaplan, Napoles-Springer, Stewart, & Perez-Stable, 2001; Ramirez, et al., 2004; Romero & Ruiz, 2007; Unger, et al., 2002; Vega, et al., 1993). Furthermore, when traditional family values decrease, such as family cohesion, support, and pride, drug use increases (Gil, Vega, & Biafora, 1998; Vega & Gil, 1998). Together, these findings underscore the important protective role that family obligation values play, and suggest that Latino youth may consciously decide to avoid drugs due to their sense of obligation to their family (Unger, et al., 2002).

Potential Mediators of the Impact of Family Obligation Values on Substance Use. Despite recent findings, the mechanisms by which family obligation values protect youth from engaging in substance use remain relatively unknown. To date, there have been no studies to examine potential mediators to explain why family obligation values are protective. In the current study, we examined whether the association between family obligation values and substance use may be mediated by avoidance of deviant peers and increased disclosure of activities to parents.

Avoidance of deviant peers and staying out of trouble are an important aspect of the family obligations of youth from Mexican backgrounds (Suarez-Orozco & Suarez-Orozco, 1995; Vega, Gil, Warheit, Zimmerman, & Apospori, 1993). A strong sense of obligation and respect for the family may reduce adolescents' tendency to associate with deviant peers who engage in high risk behaviors as such association may reflect poorly on their family (German, et al., 2009). Peer affiliation and peer pressure are one of the strongest predictors of substance use in adolescence (Ary et al., 1999; Barrera et al., 2002), and so identifying factors that reduce antisocial peer affiliation may be especially protective against substance use. For example, Brook and colleagues (1998) found that Puerto Rican adolescents whose peers used illegal drugs were also more likely to use drugs, but this association was mitigated when the adolescents endorsed high levels of familism. Thus, in the current study, we test whether family obligation values are related to decreased substance use because of adolescents' tendency to avoid deviant peers.

In addition, youth who value family obligation are more likely to disclose their activities to their parents (Yau, Taspoulos-Chan, & Smethana, 2009). Adolescent disclosure is common among Mexican adolescents, particularly in regards to personal activities, such as how they spend their free time and which friends they hang out with (Yau et al., 2009). High levels of family obligation values may be associated with the perception of being rooted within a supportive family network, and this increased sense of family support may be related to more open communication (Unger, et al., 2002). Thus, youth high in family obligation values may feel stronger attachments to their family unit and use their family as a source of support and guidance (German, et al., 2009). Because adolescents spend increasingly less time under their parents' supervision, more open disclosure of their activities may provide opportunities for parents to give their children advice and support, something they would be unable to provide without knowledge of their child's behaviors (Kerr, Stattin, & Trost, 1999). In the current study, we tested whether family obligation values are related to decreased substance use because of adolescents' tendency to have more open disclosure of their activities.

Family Assistance Behaviors and Substance Use

In contrast to work on family obligation values, comparatively less work has examined the effects of actual family assistance behaviors on adolescent substance use. Most prior work examining family assistance behaviors has focused on how it relates to youths' psychological well-being, physical health, and academic adjustment (Fuligni et al., 2009; Telzer & Fuligni, 2009a, 2009b; East, Weisner, & Reyes, 2006; Kuperminc, Jurkovic, & Casey, 2009; McMahon & Luthar, 2007), and no studies to date have examined how family assistance behaviors relate to youths' substance use. The little research that has examined family assistance behaviors suggests that it is both a stressful and meaningful daily activity. For example, high levels of family assistance are related to feelings of burden but also to feeling like a good family member, which, in turn, is associated with feelings of happiness (Telzer & Fuligni, 2009a). Moreover, adolescents who spend more time providing child care for their family experience greater stress but also greater life satisfaction and a stronger orientation towards school (East et al., 2006). Thus, the implications of family assistance are complex and likely depend on the context in which the family assistance behaviors take place.

The Role of the Context in which Family Assistance Behaviors Occur. In the current study, we explored the implications of family assistance behaviors when they take place within difficult family contexts, such as those characterized by economic strain, parent-child conflict, or when adolescents have low family obligation values. We examined whether family assistance within these more difficult contexts would be related to greater substance use. Adolescents from economically strained families may experience family assistance as more burdensome. For example, adolescents among severely economically disadvantaged families who bear heavy household responsibilities often experience more difficult adjustment and stress including school maladjustment, poor parental relations, and psychological distress (Burton, 2007; McMahon & Luthar, 2007). Thus, family assistance among economically strained families may be experienced as stressful, because these adolescents may not feel the sense of structure and support that is present in higher socioeconomic families.

In addition, the relational context of the family may be especially important for how family assistance is experienced. Because familism stresses the importance of family unity and social support, adolescents in high conflict homes may feel disconnected from their family and experience an increased sense of burden when they assist their family. Particularly for Mexican families who tend to emphasize strong family ties (Cuellar, et al., 1995; Fuligni, 2001; García-Coll & Vázquez García, 1995; Suárez-Orozco & Suárez-Orozco, 1995), family discord may be experienced as especially disruptive. Thus, these teens may act out by associating with more deviant peers and engaging in substance use as a way to cope with the negative relationships they have at home (McQueen, Getz, & Bray, 2003). In contrast, low conflict homes may be protective for youth as such teens may feel a greater sense of social support and connection when they assist their family.

Finally, adolescents' values regarding family obligation may affect whether high levels of assistance are felt as a burden. If youth do not value helping their family but engage in high levels of family assistance, this could be an indicator of "cultural conflict," which could create discord and distress (Zhou, 1997). In contrast, when adolescents highly value family obligation and engage in family assistance behaviors, they may feel closer to their family and experience a sense of reward and fulfillment that could potentially protect them from engaging in risky behavior.

Current Study

In the current study, we examined the role of family obligation values and family assistance behaviors on Mexican adolescents' substance use. We sought to add to the literature on familism and substance use in three key ways. First, we examined whether family obligation values and family assistance behaviors differentially predict substance use. Past research has shown that family obligation values are consistently related to less substance use and externalizing behaviors (German, Gonzales, & Dumka, 2009; Gil, Wagner, & Vega, 2000; Kaplan, Napoles-Springer, Stewart, & Perez-Stable, 2001; Ramirez, et al., 2004; Romero & Ruiz, 2007; Unger, et al., 2002; Vega, et al., 1993), whereas family assistance behaviors are experienced as both burdensome and meaningful (Burton, 2007; Fuligni, et al., 2009; East et al., 2006; Telzer & Fuligni, 2009a). Therefore, we predicted that family obligation values and behaviors would function in unique ways, such that family obligation values would be protective, whereas the impact of family assistance behaviors would be more complex, depending on the family context in which they occur. In other words, we expected to find a main effect of family obligation values on substance use but not a main effect of family assistance behaviors on substance use.

Our second goal was to examine the role of the family context of family obligation values and family assistance behaviors. Family assistance behaviors have been related to both positive and negative outcomes, including lower academic achievement and physical health problems

(Fuligni et al., 2009; Telzer & Fuligni, 2009b), but also to feelings of happiness and meaning (Telzer & Fuligni, 2009a). Therefore, we expected that family assistance would be a source of protection or risk depending on the context in which the assistance occurs. Within more difficult family contexts, such as those marked by economic strain, parent-child conflict, or when adolescents do not value family obligation, we expected family assistance to relate to greater substance use. In contrast, among more positive family environments, we expected family assistance to be a source of protection, relating to decreased substance use. In addition, we examined whether the family context impacts how family obligation values relate to adolescent substance use. Given that family obligation has consistently been related to dampened substance use across different studies with varying family contexts, we predicted that family obligation would be a protective factor against substance use regardless of the family context.

Finally, our third goal was to investigate the potential mediators that explain the mechanisms by which family obligation values and family assistance behaviors relate to substance use. Prior research has not examined why family obligation values are protective. Therefore, we tested whether these values are protective because adolescents are more likely to avoid deviant peers and disclose their whereabouts to their parents. Because we did not expect to find a main effect of family assistance on substance use, we examined whether any significant interactions found for family assistance behaviors would be mediated by deviant peer association or adolescent disclosure. We predicted that family assistance, within more difficult family contexts, would be related to greater substance use due to adolescents' greater tendency to associate with deviant peers and disclose to their parents less. For example, we expected that family assistance in high conflict homes would be related to higher substance use, whereas family assistance within low conflict homes would be protective. We tested whether this interaction was mediated by deviant peer association and adolescent disclosure, such that the reason family assistance in high conflict homes was a risk factor was because of adolescents' greater tendency to associate with deviant peers and disclose to their parents less.

Method

Participants

Participants included 385 (51% female) 9^{th} and 10^{th} grade adolescents (M_{age}=15.01, *SD*=.82) and their primary caregiver from Mexican backgrounds. The primary caregivers who participated were predominantly the adolescents' mother (83.1%), with 13.3% being the adolescents' father, and the remaining 3.6% being grandparents, aunts, or uncles. The majority of adolescents were from immigrant families: 12.5% were of the first generation (i.e., adolescent and parents were born in Mexico), 68.5% were of the second generation (i.e., adolescent born in the U.S. but at least one parent was born in Mexico), and 19% were of third generation or greater (i.e., both the adolescent and parents were born in the U.S.). Participants were recruited from two public high schools in the Los Angeles metropolitan area. The student body of both schools was predominantly Latin American (62% and 94%) from lower- to lower-middle class families. In both schools, over 70% of students qualified for free and reduced meals (California Department of Education, 2011).

Procedure

Classroom rosters were obtained from the participating schools and then were randomly allocated for study recruitment across the school year. Each week, a few classrooms were selected, and presentations about the study were given to students. In the classroom presentations, students were told that the purpose of this study was to better understand the daily lives of families from Mexican backgrounds. In addition, consents were mailed to students' homes, and phone calls to parents were made to determine interest and eligibility. Both the adolescent and the adolescents' primary caregiver (i.e., the individual who spent the most time with the adolescent and knew about the adolescents' daily activities) had to be willing to participate in the study and to report a Mexican background. A total of 428 families agreed to participate, which represents 63% of families who were reached by phone and determined eligible for the study. Our final sample of 385 students are those who provided sufficient information regarding their family obligation values, family assistance behaviors, and substance use, and the analyses presented in this paper focus on these adolescents.

Interviewers visited the home of participants where primary caregivers participated in a personal interview and the adolescent completed a self-report questionnaire, each of which took approximately 45-60 minutes to complete. All interviewers were bilingual in English and Spanish and administered the interview in whichever language the parent preferred. Seventy-one percent of parent completed the interview in Spanish. Only 1.6% of adolescents completed the self-report questionnaire in Spanish. Next, participants were provided with fourteen days of diary checklists to complete every night before going to bed for two subsequent weeks. The three page diary checklists took approximately five to ten minutes to complete each night. Participants were instructed to fold and seal each completed diary checklist each night and to stamp the seal with an electronic time stamper. The time stamper imprinted the current date and time and was programmed with a security code such that adolescents could not alter the correct time and date. Participants were told that if inspection of the data indicated that they had completed the checklists correctly and on time, each family would also receive two movie passes. At the end of the two week period, interviewers returned to the home to collect the diary checklists. Adolescents received $30 for participating and their primary caregiver received $50. The time-stamper monitoring and the cash and movie pass incentives resulted in a high rate of compliance, with 95% of the dairies being completed by adolescents.

Measures

Substance Use. Participants completed a measure indicating their lifetime substance use (Youth Risk Behavior Survey Questionnaire; Centers for Disease Control and Prevention, 1989). This in-depth questionnaire asks about lifetime use (e.g., if you have ever tried marijuana, how old were you when you tried it for the first time?) for the following substances: cigarettes, alcohol (including beer, wine, wine coolers, and liquor, but does not include drinking a few sips of wine for religious purposes), marijuana (e.g., pot, weed, grass, hash, etc.), cocaine (e.g., powder, crack or freebase), crystal meth (also called "ice" or “glass”), and other illegal drugs (e.g., LSD, PCP, ecstasy, mushrooms, speed, or heroin).

There are well-delineated stages and sequences of drug use during adolescence. Stage-sequential models of adolescent substance use typically posit a general sequence with the following stages (1) nonuse, (2) substances that are legal for adults (e.g., tobacco and alcohol), (3) marijuana use, (4) use of illicit substances, (5) regular use of substances (Spoth et al., 1999; Golub & Johnson, 2001; Kandel, Warner, & Kessler, 1998). In the current study, each participant was coded according to the highest stage of involvement in this hierarchy where 0=never tried any type of substance, 1=tried legal substances for adults (alcohol or cigarettes) at least once but have not used these substances more than one or two days in the past month, 2=tried marijuana at least once but have not used it more than one or two days in the past month, 3=tried hard substances (cocaine, crystal meth, or other illegal drugs) at least once but have not used any of these substances more than one or two days in the past month, 4=regular use of alcohol or cigarettes (at least 3-5 days in the past month), 5=regular use of marijuana (at least 3-9 times in the past month), and 6=regular use of illicit drugs (at least 3-9 times in the past month). Note that being classified in one stage does not imply use of substances in the preceding stages. For example, adolescents whose highest stage of substance use is marijuana may or may not have used tobacco and/or alcohol. However, adolescents are unlikely to experiment with marijuana without prior experimentation with alcohol or tobacco (Kandel, et al., 1998).

Family Obligation Values. Adolescents completed 12 items that assessed their attitudes regarding providing assistance to their family (Fuligni, Tseng, & Lam, 1999). Using a 5-point scale (1=almost never to 5=almost always) adolescents indicated how often they felt they should assist with household tasks and spend time with their family, such as "help take care of your brothers and sisters," "eat meals with your family," and "spend time with your family on weekends." The scale's internal consistency was α=.81.

Family Assistance Behaviors. Each evening for fourteen days, adolescents indicated whether they had engaged in any of the following 9 activities: helped clean the apartment or house, took care of siblings, ran an errand for the family, translated for parents, helped siblings with their schoolwork, helped parents with official business (for example translating letters, completing government forms), helped to cook a meal for the family, helped parents at their work, and other. This list of activities was derived from focus group studies of adolescents and has been used successfully in previous studies with Mexican adolescents (e.g., Telzer & Fuligni, 2009b). From these 14 days of responses, we created an index, *Family Assistance Behaviors*, which represents the proportion of days out of 14 days that the adolescent reported helping his/her family by engaging in any one of the 9 assistance behaviors.

Deviant Peer Association. Participants indicated how many of their friends (1=none to 5=almost all) engaged in 15 deviant behaviors in the past month, such as got drunk or high, cheated on school tests, started a fight with someone, and stole something (Barrera, et al., 2002). All 15 items were averaged to create one index of Deviant Peer Association, which an internal consistency of α=.92.

Adolescent Disclosure. To examine adolescents' willingness to disclose their activities to their parents, participants used a 5-point scale (1=almost never to 5=almost always) to respond to 5 items (Stattin & Kerr, 2000). For example, "do you hide a lot from your parents about what you do during nights and weekends" and "do you spontaneously tell your parents about your friends". The scale's internal consistency was α=.73.

Parent-Child Conflict. Adolescents responded to 10-items assessing the frequency of parent-child conflicts and arguments in their home in the past month (Ruiz, Gonzales, & Formoso, 1998). For example, "you and your parents yelled or raised your voices at each other", "you and your parents ignored each other" and "your parents let you know that they were angry or didn't like something you said or did". Adolescents used a 5-point scale ranging from 1=almost never to 5=almost always. The scale's internal consistency was α=.86.

Economic Strain. The adolescents' primary caregiver completed a measure indicating their families' financial well being with 9 items that tapped economic strain over the past 3 months (Conger et al., 2002). The primary caregiver indicated how much difficulty they had paying bills (1=no difficulty at all to 4=a great deal of difficulty), whether they had money left over at the end of each month (1=more than enough money left over to 4=very short of money), and whether they could afford different necessities such as food, medical care, and clothing (1=very true to 4=not at all true). The scale's internal consistency was α=.90.

Socioeconomic Status. All analyses described in this paper control for socioeconomic status. The primary caregiver reported their own and their child's secondary caregiver's (usually the father) highest level of education by responding to a scale that ranged from "elementary/junior high school," "some high school," "graduated from high school," "some college," "graduated from college," to "law, medical, or graduate school." The primary caregiver also reported their own and their child's secondary caregiver's occupation, which was then coded according to a five point scale used in previous studies with a similar population (Fuligni, 1997, 1998) ranging from 1 (*unskilled level*) to 5 (*professional level*); examples of unskilled worker included such occupations as furniture mover, gas station attendant, food service worker, and housecleaner; semiskilled worker included baker, cashier, landscaper, and security guard; skilled worker included appraiser, barber, seamstress, and electrician; semiprofessional worker included nurse, librarian, optometrist, and office manager; and professional worker included architect, dentist, computer consultant, and physician. If the participant indicated a parent was unemployed, occupational status was not coded. Socioeconomic status was calculated by standardizing and averaging mother's and father's education and occupation. See Table 2.1 for descriptives of participants' family's socioeconomic status and household structure.

Results

Descriptives

Family Assistance Behaviors and Family Obligation Values. Overall, 99% of adolescents helped on at least one day of the study. Helping with household tasks, such as cleaning, cooking, and running errands for the family was the most common type of activity reported by adolescents, occurring on 70% of days. Helping siblings by taking care of them and assisting them with their homework was the next most frequent type of activity (43% of days[1]),

[1] *Note.* Assisting siblings was only calculated for adolescents with siblings.

followed by helping parents with official business and at their work (16.7% of days). Adolescents engaged in approximately 1.88 (*SD* = 1.25) types of assistance tasks per day and provided some type of assistance to the family on 79% of days. Approximately one-third of adolescents assisted their family on 100% of the study days, and 17.1% of adolescents assisted on 50% or fewer of the study days, 1% of whom assisted on 0 days.

Males and females did not differ in their family obligation values, but they did differ in their family assistance behaviors. Girls reported helping their family in any one of the types of assistance tasks on 82% of days whereas boys assisted on 76% of days, $t(383)=2.44$, $p=.005$. Males and females did not differ in the number of days they assisted their parents or siblings, but they did differ in the number of days they assisted with household tasks (females: 75.8% of days, males: 63.9% of days; $t(383)=4.20$, $p<.001$). There were no generational differences in family obligation values, whereas there were differences in family assistance behaviors. First generation youth assisted their family on more days by engaging in any assistance task (88% of days) than second (78.6% of days) or third (74.9% of days) generation youth, $F(2,382)=4.29$, $p<.05$, $\eta^2=.02$. Similar generational differences were found for assisting parents and assisting with household tasks. There were no generational differences in assisting siblings.

Family obligation and assistance did not differ depending on whether the household was a single versus dual parent household. Adolescents with more siblings tended to value family obligation more ($r = .11$, $p < .05$), assisted their family on more days overall ($r = .13$, $p < .05$), assisted siblings on more days ($r = .27$, $p < .001$), and assisted with household tasks on more days ($r = .12$, $p < .05$). Finally, family socioeconomic status was only related to assisting parents, such that adolescents from lower SES homes helped their parents on more days ($r = .20$, $p < .001$).

Substance Use. In terms of lifetime substance use, less than half of the sample (45.7%) had never tried any substance (substance stage 0), 18.7% had tried cigarettes or alcohol at least once but had not used either substance more than one or two times in the past month (substance stage 1), 13.8% had tried marijuana at least once but had not used it more than one or two times in the past month (substance stage 2), 5.5% had tried cocaine, crystal meth, or other illegal drugs at least once in their lifetime but had not used any of these substances more than once or twice in the past month (substance stage 3), 4.4% had used alcohol or cigarettes at least 3 times in the past month (substance stage 4), 8.3% had used marijuana at least 3 times in the past month (substance stage 5), and 3.6% had used cocaine, crystal meth, or other illegal drugs at least 3 times in the past month (substance stage 6). These rates are similar to those found among national prevalence rates of adolescent substance use (e.g., Johnson et al., 2009). Males and females did not differ in their substance use. Substance use also did not differ depending on parental socioeconomic status or household structure. In terms of generational status, one difference emerged such that first generation youth were more likely to be in a higher substance use stage (M=2.04, SD=2.01) than second generation youth (M=1.35, SD=1.72), $F(2,382)=3.11$, $p<.05$, $\eta^2=.02$.

Bivariate Correlations

Correlational analyses showed that family obligation values were associated with lower lifetime substance use, less association with deviant peers, and greater adolescent disclosure. Family assistance behaviors, on the other hand, were not related to substance use or to association with deviant peers, but were related to greater adolescent disclosure (Table 2.2).

Regressing Family Obligation Values and Family Assistance Behaviors on Substance Use

Analysis Plan. To test our primary hypotheses, a hierarchical regression analysis was conducted. Our first research question examined whether family obligation values and family assistance behaviors differentially predict substance use. In the first model, family obligation values and family assistance behaviors were simultaneously entered to predict lifetime substance use. This allowed us to examine how family obligation and family assistance relate to substance use above and beyond the effect of the other. Variables known to differentially relate to substance use or to vary by familism were entered as controls (gender, generation, SES, family structure, age).

Our second research question examined whether the family context in which family obligation and family assistance occur has an influence on how each relate to substance use. Therefore, in the second model, contextual variables as well as their interactions with the familism variables were entered into the model to examine whether the effects of family obligation values and family assistance behaviors depended upon the context in which they took place, including parent-child conflict, economic strain, and family obligation values.

Our third research question examined whether deviant peer association and adolescent disclosure explained why family obligation is protective. We also tested whether deviant peer association and adolescent disclosure explained why family assistance, within more difficult family contexts, related to increased substance use (i.e., mediated moderation). Therefore, in the third model, deviant peer association and adolescent disclosure were entered to examine whether each mediated any of the significant associations found in the first and second models.

Results. As shown in Table 3 model 1, family obligation values and family assistance behaviors were differentially related to substance use: family obligation values were related to less substance use whereas family assistance behaviors were not related to substance use.

Next, to examine whether the association of family obligation values and family assistance behaviors on substance use depended upon the context of the family, we entered interaction terms in the second model. We examined three potential contextual variables including economic strain, parent-child conflict, and adolescents' family obligation values. Using the guidelines of Aiken and West (1991) to estimate interaction effects using multiple regression, we computed interaction terms by centering the moderator variables and multiplying them by the centered version of family assistance and family obligation. The interaction terms were then entered into multiple regression analyses along with the centered moderators, family assistance, and family obligation to predict substance use. Gender, generation, socioeconomic status, and family composition were included as controls.

Whereas the family context did not impact how family obligation values were related to substance use, one aspect of the family context did modify the association of family assistance behaviors with substance use. Specifically, we found a significant interaction of family assistance and parent-child conflict (see Table 2.3, model 2). We probed the interaction based on the methods outlined by Aiken & West (1991) and Cohen and Cohen (1983) in which the simple slope of family assistance behaviors on substance use were examined at family conflict levels 1 SD below and above the mean. As shown in Figure 2.1, family assistance behaviors, within families marked by low parent-child conflict (i.e., 1 SD below the mean), were not associated with substance use (b=-.43, *ns*), whereas family assistance behaviors, within high parent-child conflict homes (i.e., 1 SD above the mean), were associate with greater substance use (b=2.32, p<.05). Although adolescents in households marked by greater economic strain tended to assist their family more (r=.12, p<.05), economic strain did not moderate the association between family assistance and substance use. Moreover, we did not find a significant interaction between family assistance behaviors and family obligation values, suggesting that the extent to which adolescents value family obligation does not impact how family assistance relates to substance use.

Finally, in the third model, we entered deviant peer association and adolescent disclosure to examine whether the main effect of family obligation values and the interactive effect of family assistance with family conflict were mediated by adolescents' disclosure to their parents and deviant peer association. The mediation analyses were conducted with the procedures outlined by Baron and Kenny (1986), in which the magnitude and the significance of the indirect effects of family obligation values on substance use, through deviant peer association and adolescent disclosure, were estimated.

As shown in model 3 of Table 2.3, the original effect of family obligation values on substance use is reduced and becomes non-significant when deviant peer association and adolescent disclosure are entered into the model. To test for the significance of the indirect effect, we used a Sobel test. Association with deviant peers accounted for 29.6% of the original effect of family obligation values on substance use (B=.14, SE=.05, Z=2.98, p<.001), and adolescent disclosure accounted for 43.1% of the original effect (B=.20, SE=.03, Z=7.3, p<.001). Therefore, the greater tendency of adolescents with higher family obligation values to disclose to their parents and associate with fewer deviant peers accounts for 72.7% of the tendency for adolescents with higher family obligation values to have lower lifetime substance use. Next, we conducted post hoc tests of the significance of the mediation analyses using MacKinnon and colleagues' (2007) PRODCLIN program, which computes asymmetric confidence limits based on the distribution of products. These confidence limits are more powerful and have more accurate Type I error rates than Baron and Kenny's (1986) method (MacKinnon et al., 2007).

The confidence intervals of the indirect effects do not include zero (deviant peer association CI= .05 - .24; adolescent disclosure CI= .10 - .32), consistent with a statistically significant mediation.

Finally, we examined whether the significant interaction term of family assistance x parent-child conflict was mediated by deviant peer association and adolescent disclosure. In other words, do adolescents in high conflict homes exhibit greater substance use when they help their family more because they tend to associate with more deviant peers and disclose to their parents less? As shown in the third step of Table 2.3, the direct effect of the interaction term of family assistance x parent-child conflict on substance use was reduced when deviant peer association and adolescent disclosure were entered in the model. Mediated moderation analyses were run according to Muller and colleagues (2005), in which (1) the interaction between the independent variable (family assistance) and the moderator (parent-child conflict) in its effect on the outcome variable (substance use) must be significant, (2) the interaction between the independent variable and the moderator in its effect on the mediator (deviant peer association and adolescent disclosure) must be significant, and (3) the direct effect of the mediator on the outcome variable must be significant. Only deviant peer association met these criteria ((1) family assistance x parent-child conflict → substance use: b=.22, p<.05, (2) family assistance x parent-child conflict → deviant peer association: b=.07, p<.05, (3) deviant peer association (controlling for family assistance x parent-child conflict) → substance use: b=1.44, p<.001). Family obligation values, generation, gender, SES, age, and family composition were controlled for in all analyses.

To test for the significance of the indirect effect, we used a Sobel test. Association with deviant peers accounted for 29.4% of the original effect of the parent-child conflict interaction on substance use (*B*=.09, *SE*=.04, *Z*=2.2, $p<.05$). We conducted post hoc tests of the significance of the mediation analyses using MacKinnon and colleagues' (2007) PRODCLIN program. The confidence interval of the indirect effect does not include zero (CI= .01 - .17), consistent with a statistically significant mediation.

Discussion

Adolescent substance use is one of today's most important health problems, and may be particularly problematic among Mexican origin youth. Attending to the health of this growing population should be a central concern and seen as an investment in the health of the country (Ojeda, Patterson, & Strathdee, 2008). Thus, it is essential to identify protective factors that may reduce adolescents' health risk behaviors and mollify ethnic disparities in substance use. Recent recommendations by child development researchers have stressed the importance of focusing on culturally relevant risk and protective factors that may foster positive adjustment among ethnic minority youth (García Coll, et al., 1996; García Coll & Garrido, 2000). Consistent with this recommendation, we examined how familism, a culturally important aspect of family relationships among those from Mexican backgrounds, may serve as a source of protection or risk for adolescent substance use. Results suggest that family obligation values are consistently protective for Mexican adolescents' substance use, whereas family assistance behaviors are a risk factor, relating to higher levels of substance use within high conflict families. These findings suggest that cultural values are protective for Mexican adolescents, but the translation of these values into behaviors can potentially be a source of stress, relating to heightened substance use.

Family Obligation Values and Substance Use

Family obligation values were consistently related to lower levels of substance use, and this did not vary as a function of the family context. Thus, even as many families face difficult circumstances, such economic strain, family obligation values are a source of protection for adolescent substance use. As Mexican adolescents acculturate to U.S. culture, their levels of substance use and delinquent behaviors are more likely to increase (Lovato et al., 1994). Therefore, retaining cultural values of family obligation can be a protective factor against the stresses that may accompany acculturation.

Although several studies have highlighted the protective role that family obligation values play for adolescents' health risk behaviors (e.g., German, et al., 2009; Gil, et al., 2000; Kaplan, et al., 2001; Ramirez, et al., 2004; Romero & Ruiz, 2007; Unger, et al., 2002; Vega, et al., 1993), we know little about the mechanisms by which it is protective. In the current study, we found that family obligation values were associated with lower levels of substance use because adolescents were less likely to associate with deviant peers and more likely to disclose their activities to their parents. Although our data are cross-sectional and do not provide information about the direction of the effects over time, these findings are suggestive of mediation.

Greater family obligation values may help adolescents to feel more connected to and supported by their family. Thus, adolescents with greater family obligation values may be more willing to share their daily experiences with their family (Yau et al., 2009). Such disclosure may open up family discussions about appropriate behavior and strategies for dealing with peer pressure. Adolescents spend increasingly more time away from their parents' supervision. When adolescents disclose their activities to their parents, such as where they go after school or what they did with their friends on the weekend, parents are more likely to understand the types of situations their children become involved in, who their children decide to spend time with, and how responsibly they act in different situations (Kerr, et al., 1999). Parents can then provide advice and support, helping their child develop coping strategies to avoid substance use. Higher levels of disclosure between teens and parents can also help adolescents understand the importance of familism – to experience it directly in close relationships with others.

Adolescents who value family obligation may also avoid deviant peers because such peer relationships would reflect poorly upon their family (German, et al., 2009), or they may not need the connections to peers because family members provide closer connections already. Given the increasingly strong influence of peer pressure during adolescence, avoidance of peers who engage in risky behavior may be one of the strongest protective factors against substance use (Ary, et al., 1999; Barrera, et al., 2002). Thus, family obligation values may be especially protective because of adolescents' greater tendency to avoid deviant peers.

Family Assistance Behaviors and Substance Use

To our knowledge, no previous research has examined how family assistance behaviors relate to adolescents' substance use. Our findings suggest that family assistance behaviors function in qualitatively different ways than family obligation values. Whereas values were beneficial for all adolescents, family assistance behaviors were not beneficial. In fact, family assistance behaviors were a risk factor for some adolescents, relating to higher levels of substance use when the assistance took place within high conflict homes. These results are consistent with prior work suggesting that family assistance is experienced as both demanding and stressful at times (Burton, 2007; Fuligni, et al., 2009; Telzer & Fuligni, 2009a, Telzer & Fuligni, 2009b).

Parent-child conflict may be especially distressing among families from Mexican backgrounds who tend to emphasize strong family solidarity and connection (Cuellar, et al., 1995; Fuligni, 2001; Suarez-Orozco & Suarez-Orozco, 1995). Mexican adolescents who report more frequent conflicts with their parents may feel disconnected from their family, experience an increased sense of burden when they assist their family, and feel greater emotional distress, which can lead to heightened substance use (Tschann et al., 2002). Thus, these teens may enact poor coping mechanisms and act out by associating with more deviant peers and engaging in substance use as a way to deal with the conflicts they may feel at home (McQueen, et al., 2003). Indeed, mediation analyses suggested that one reason why family assistance behaviors, within high conflict homes, related to greater substance use was because of adolescents' greater tendency to associate with deviant peers.

We did not find that the economic context of the household affected how family assistance behaviors were experienced. Although adolescents assisted their family more when they came from families with higher economic strain, this was not related to their substance use. Interestingly, economic strain itself was not related to substance use, suggesting that being poor, in and of itself, is not necessarily a risk factor for substance use. Although previous work has found that adolescents among economically disadvantaged families experience adjustment difficulties when they assist their family (Burton, 2007), our results suggest that this does not translate into substance use problems. Perhaps adolescents in economically strained households understand that their assistance is essential for the well-being of their family and thus do not act out by engaging in risky behavior such as substance use. In contrast to the cultural conflict they may experience when they are in high conflict homes, higher levels of family assistance behaviors within economically disadvantaged families may be experienced as culturally congruent because the adolescents understand the importance of their family assistance for the well-being of their family. These adolescents may still experience a sense of burden and distress (Burton, 2007), but they may avoid behaviors that could hurt the family.

Limitations and Future Directions

The current study examined how family obligation values and family assistance behaviors are related to Mexican adolescents' substance use. Future studies should examine whether family obligation is also protective for Asian youth who also tend to place great emphasis on family solidarity and support (Fuligni et al., 1999) or for those families from any cultural background who, relative to others, emphasize familism. Additionally, researchers should continue to identify other culturally relevant factors that may be protective against adolescent substance use, such as parental involvement in school activities, religious participation and beliefs, positive peer relationships, and participation in meaningful activities such as after school programs or sports teams. Because youth from different cultures place different emphasis on family, peers, and school, these agents may differentially affect youths' substance use and risk taking behaviors. Future research should examine how each of these agents differentially impact adolescent substance use across diverse adolescents.

Given the cross-sectional nature of the study, we are unable to determine the direction of the effects. Although we propose that family obligation values lead to lowered substance use, it is also possible that adolescents who engage in higher substance use experience dampened ties to their family over time. Future longitudinal research should examine the direction of these effects, adjusting for the stability of drug use over time. Identifying the direction of the effects could inform interventions designed to reduce substance use. If longitudinal research found that family obligation values and family assistance behaviors indeed lead to adolescent substance use, interventions could be designed to focus on increasing cultural values of family obligation but at the same time focusing on the relational qualities within the home such that the translation of these values into behaviors are not experienced as stressful.

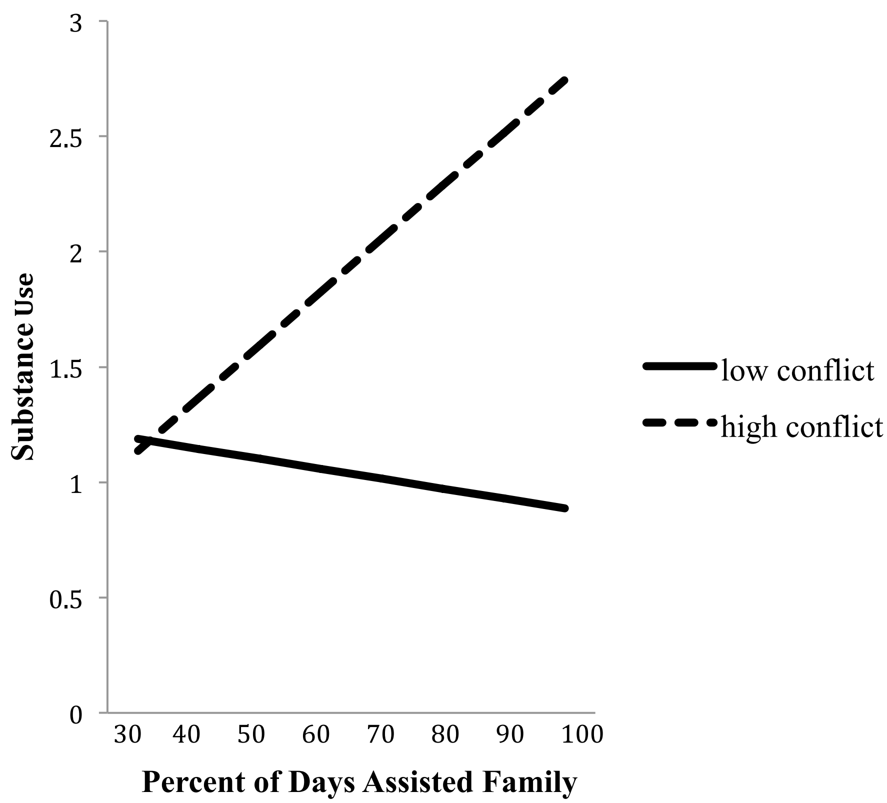
Family obligation and assistance have important, yet distinct, implications for substance use among adolescents from Mexican backgrounds. As a result, it is essential for programs designed for this population to consider how these issues present both strengths *and* challenges. Without considering both the risks and benefits that family obligation and assistance can provide, interventions designed to reduce substance use may actually have iatrogenic effects because of the variability in the dynamics of family obligation and assistance among those from Mexican backgrounds. For instance, intervention that focus on promoting a sense of obligation to the family might result in high levels of assistance that, for some adolescents in some families, would have negative implications for substance use.

Conclusions

This study contributes to our understanding of how cultural values and behaviors relate to adolescents' health risk behaviors broadly, and specifically how familism can be both beneficial and costly for Mexican adolescents' substance use behaviors. We examined an aspect of family life that is culturally relevant to Mexican families. By taking this approach, we were able to identify a "cultural resource" (German et al., 2009) for these families, identifying how and when familism can be a protective or risk factor. We add to the literature on familism and substance use in several ways. First, we examined how family obligation values and family assistance behaviors uniquely contribute to adolescents' substance use – whereas values were protective, behaviors were a source of risk, depending on the context of the family. Second, we were able to identify family contexts that impacted how family assistance behaviors were experienced – only in high conflict homes did family assistance relate to higher levels of substance. Third, we identified the mechanisms by which family obligation values are protective – through decreased association with deviant peers and increased adolescent disclosure.

In conclusion, family obligation and assistance are fundamental aspects of family life and have important implications for substance use among adolescents from Mexican backgrounds. Our findings suggest that Mexican adolescents' decisions to engage in substance use may depend upon their cultural values and behaviors. Mexican adolescents' beliefs in supporting and spending time with their family are protective against substance use. Yet, despite their strong family obligation values, family assistance behaviors can sometimes be costly, relating to greater substance use when it takes place within high conflict homes.

Figure 2.1. Family assistance behaviors relate to higher levels of substance use within high conflict homes, whereas assisting the family within low conflict homes is not related to substance use.



Note. Family Assistance values are limited to scores within 2 standard deviations of the mean.

Table 2.1. Socioeconomic Background and Family Composition

Variable	N	(Percent of sample)
Parental Employment		
Unemployed	12	(3.1)
Unskilled	36	(9.4)
Semi-Skilled/Skilled	212	(55.1)
Semi-Professional/Professional	85	(22.1)
Mother's Education		
Did not complete high school	244	(65.4)
Completed high school	30	(7.8)
Completed some college	63	(16.4)
Completed 2-year college	20	(5.2)
Completed 4-year college	13	(3.4)
Father's Education		
Did not complete high school	250	(72.9)
Completed high school	42	(10.9)
Completed some college	25	(6.5)
Completed 4-year college	13	(3.4)
Completed advanced degree	13	(3.4)
Family Composition		
Dual parent household	335	(87.0)
Only child	49	(12.7)

Note. Parental employment represents the highest level of employment of either parent. Dual parent household represents whether there are at least 2 adults in the home. Of the 335 dual parent households, 178 had more than 2 adults.

Table 2.2. Bivariate Correlations Between Family Obligation, Family Assistance, Substance Use, Deviant Peer Association, and Adolescent Disclosure

	1	2	3	4	5
1. Family Obligation Values	1				
2. Family Assistance Behaviors	.28***	1			
3. Lifetime Substance Use	-.18***	.04	1		
4. Deviant Peer Association	-.13**	.02	.46***	1	
5. Adolescent Disclosure	.41***	.14**	-.36***	-.28***	1

Note. ** $p < .01$, *** $p < .001$.

Table 2.3. Family Obligation Values and Family Assistance Behaviors on Substance Use

	Model 1		Model 2		Model 3	
	B(SE)	*β*	*B(SE)*	*β*	*B(SE)*	*β*
Intercept	1.84(1.88)		1.70(1.83)		-.08(1.73)	
Family Obligation Values	-.34(.10)***	-.19	-.32(.09)***	-.18	-.09(.09)	-.05
Family Assistance Behaviors	.14(.10)	.08	.09(.11)	.05	.09(.09)	.05
First Generation	.68(.36)	.13	.71(.36)*	.13	.45(.32)	.08
Second Generation	.03(.27)	.01	.07(.26)	.02	-.05(.24)	-.01
Parental SES	.07(.13)	.03	.12(.13)	.51	.12(.12)	.06
Gender	-.09(.18)	-.03	-.25(.18)	-.07	-.08(.16)	-.02
Single/Dual Parent Household	.40(.28)	.08	.42(.27)	.08	.46(.24)	.09
Number of Siblings	-.08(.08)	-.05	-.07(.08)	-.04	-.11(.07)	-.07
Age	.00(.01)	-.01	.00(.10)	-.01	.01(.01)	.03
Parent-Child Conflict			.36(.09)***	.20	.11(.09)	.06
Economic Strain			.09(.10)	.05	.10(.09)	.06
Family Obligation x Parent-Child Conflict			.18(.10)$^{+}$	-.09	-.13(.09)	-.07
Family Obligation x Economic Strain			-.01(.10)	-.01	.00(.09)	.00
Family Assistance x Parent-Child Conflict			.30(.11)**	.15	.18(.10)$^{+}$	.09
Family Assistance x Economic Strain			.01(.09)	.01	.05(.08)	.03
Family Assistance x Family Obligation			-.14(.08)$^{+}$	-.09	-.13(.07)	-.08
Adolescent Disclosure					-.42(.10)***	-.21
Deviant Peer Association					1.16(.15)***	.37

Note. .$^{+}$ p <.10, * p <.05, ** p < .01, *** p < .001. Generation was dummy coded as first and second generations=1 such that third generation adolescents served as the reference group; Gender was coded females=1 males=0; SES=socioeconomic status, which was computed as the standardized mean of mother and father's education and occupation; single/dual parent household was coded as single=1 dual=0; age was entered in months.

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Chapter 3

Meaningful Family Relationships: Neurocognitive Buffers of Adolescent Risk Taking

Adolescence is a time of heightened vulnerability for risk taking behavior, impulsivity, and reckless behavior. Adolescents are more likely than adults to experiment with and abuse drugs and alcohol, to have unsafe sex, and to engage in violent and reckless behaviors (Dahl, 2004; Steinberg, 2008). These risky behaviors underlie many behavioral and health problems that contribute to the public health burden during the adolescent period, contributing to a two to three fold increase in morbidity and mortality rates (Arnett, 1992; Chambers, Taylor, & Potenza, 2003; Dahl, 2004).

Evidence from developmental neuroscience suggests that risk taking behavior increases during adolescence partly due to changes in two neural systems that affect decision making (Steinberg, 2008; Luna, Padmanabhan & O'Hearn, 2010; Somerville, Jones & Casey, 2010). Subcortical limbic regions, which comprise neural regions associated with the evaluation of rewards (e.g., the ventral striatum) mature relatively early, leading to increased reward seeking during adolescence (Ernst et al 2006; Galvan et al., 2006; Galvan et al., 2007). In contrast, cortical regions, which comprise neural regions involved in higher order cognition, goal directed behavior, and impulse control (e.g., the lateral prefrontal cortex, lPFC) gradually matures over adolescence and into adulthood (Eshel et al., 2007; Geidd, 2008; Luna et al., 2010). Immature cognitive control development relative to the reward system may hinder appropriate evaluation of risk and bias youth towards risky decisions.

Dual systems theories of neurobiological development offer a promising way to understand why adolescents are vulnerable to risk taking, but there is little understanding of how these neural mechanisms interact with social processes to promote or prevent risk taking. Risk taking does not occur in a social vacuum and it is critical to examine how neural mechanisms interact with fundamental social processes during adolescence. Thus, it is important to understand what factors shape the developmental trajectories of cortical and subcortical brain function, potentially reducing the neural imbalance in adolescence.

Recent neuroimaging research suggests that the social context can modulate activation in these neural systems. For example, the presence of peers enhances activation in the reward network during risk taking among adolescents (Chein et al, 2010), suggesting that peers may *increase* the neural imbalance implicated in adolescent risk taking. Perhaps this occurs because peers increase the perceived benefits of risk (Gardner & Steinberg, 2006) and may thus increase reward sensitivity. In contrast, relationships that make risk taking comparatively less rewarding (e.g. family relationships), by increasing the perceived negative consequences of risk as well as by providing opportunities to practice self control, may decrease this neural imbalance.

The changing nature of family relationships during the adolescent years can have significant implications for risk taking and associated health consequences, such as substance use and externalizing problems (Gfroerer & de la Rosa, 1993; Warner et al., 2006). Family obligation – the importance of spending time with the family, high family unity, family social support, and interdependence for daily activities (Cuellar et al., 1995; Fuligni, 2001) – is a key aspect of family relationships that may have significant consequences for risk taking. Indeed, family obligation and family pride have been associated with reduced likelihood and delayed onset of drug use, and lower rates of externalizing problems (German, Gonzales, & Dumka, 2009; Gil, Wagner, & Vega, 2000; Kaplan, Napoles-Springer, Stewart, & Perez-Stable, 2001; Ramirez & de la Cruz, 2003; Romero & Ruiz, 2007; Unger et al., 2002; Vega, Zimmerman, Warheit, Apospori, & Gil, 1993).

Adolescents who value family obligation often put the needs of their family before their own (Fuligni, Tseng, & Lam, 1999), which may help them exert self control in order to make decisions that benefit their family. Moreover, family obligation values stress the importance of considering future family needs (Fuligni et al., 1999); thus, family obligation may increase adolescents' goal directed behavior and ability to plan ahead. Youth who internalize their family's values show decreased cognitive impulsivity and an increased ability to delay gratification and inhibit undesirable behaviors (Eisenberg et al., 2005; Olson, Bates, & Bayles, 1990). Youth who value family obligation report greater negative consequences for engaging in risky behavior because risk taking would reflect poorly upon their family (German et al., 2009). Therefore, the negative consequences of risk taking may be more consequential for these youth, which may render risky behavior less salient and rewarding for them.

The protective effect of family obligation is particularly true for those who report a greater sense of meaning and reward from assisting their family. Participating in a daily routine such as family assistance that is meaningful with respect to group goals and values leads to enhanced well being and builds confidence (Weisner, Matheson, Coots, & Bernheimer, 2005). Indeed, we have found that adolescents who assist their family more feel that they are fulfilling important roles within their family and have higher levels of daily happiness (Telzer & Fuligni, 2009). Thus, family relationships that are personally meaningful, build confidence, and provide adolescents with a sense of reward may be particularly protective against risk taking. Therefore, family obligation represents a distinct aspect of family relationships that may reduce risk taking because it is both a meaningful activity as well as provides opportunities for adolescents to control their own impulses and desires for the sake of their family.

Recent functional magnetic resonance imaging (fMRI) research suggests that family obligation involves brain regions that have been implicated in both reward and cognitive control. For example, when making a decision to lose money so that their family can gain a cash reward, adolescents who report a greater sense of meaning and fulfillment from helping their family in everyday life show greater activation in neural regions responsive to reward (e.g., ventral striatum; Telzer et al., 2010). Moreover, those who report greater family obligation values show enhanced activation in neural regions implicated in cognitive control (e.g., lPFC; Telzer et al., 2011). These results suggest that decisions to support the family recruit brain regions often associated with activities involving reward and cognitive control. As described earlier, these are the very same regions that show a maturational imbalance during adolescence and are implicated in risky decision making (Steinberg, 2008; Somerville et al., 2010). Thus, family obligation may relate to lower levels of risk taking by altering activity in neural regions involved in reward sensitivity and cognitive control, thereby decreasing the neural imbalance implicated in risk taking.

In the current study, we sought to answer two key questions. First, how does family obligation relate to neural markers of risk taking? We predicted that family obligation would be associated with decreased ventral striatum activation during a risk taking task and increased lateral prefrontal cortex activation during a behavioral inhibition task. Moreover, because family obligation provides opportunities for adolescents to practice self control and goal-directed behavior and may increase the perceived negative consequences of risk taking, we tested whether family obligation would be uniquely protective against risk taking, above and beyond the effects of more general levels of emotional cohesion in the family. Therefore, we examined how family obligation and family cohesion and support simultaneously predict neural responses to reward and cognitive control. Second, does activation in the ventral striatum and lateral PFC predict adolescents' real-life risk taking behavior and decision making skills? Recent advances in neuroimaging have linked neural response to risk taking and decision making with real-life behaviors. For example, ventral striatum sensitivity to reward is associated with increased likelihood of risk taking behaviors among adolescents (Galvan et al., 2007). In the current study, we predicted that neural regions that are sensitive to family obligation during reward (e.g., the ventral striatum) will relate to less risk taking behavior, and neural regions sensitive to family obligation during cognitive control (e.g., DLPFC) will relate to better decision making skills.

We focus on the links between family obligation and neural markers of risk taking among adolescents from Mexican backgrounds. The family may be an especially important protective factor for Latino youth (de la Rosa, 1988; Gfoerer & de la Rosa, 1993; Warner et al., 2006) who place particular value on family obligation and spend twice as much time helping their family each day compared to their European American peers (Cuellar, Arnold, & Gonzales, 1995; Garcıa Coll & Vazquez Garcıa, 1995; Suarez-Orozco & Suarez-Orozco, 1995; Fuligni, 2001; Telzer & Fuligni, 2009). Indeed, staying out of trouble is an important aspect of the family obligations of youth from Mexican backgrounds (Suarez-Orozco & Suarez-Orozco, 1995; Vega, Gil, Warheit, Zimmerman, & Apospori, 1993).

Methods

Participants

Forty-eight adolescents from Mexican backgrounds participated in an fMRI scan. Participants ranged in age from 14-16 years (M_{age}=15.23; 21 males, 27 females). All but one participant spoke and read English fluently. For the Spanish-speaking participant, all tasks and questionnaire measures were described and administered in Spanish. Participants completed written consent and assent in accordance with UCLA's Institutional Review Board.

Questionnaire Measures

Family Obligation Values. Participants used a 5-point scale (1= "almost never" to 5= "almost always") to respond to 12 questions describing their expectations for how often they should assist with household tasks and spend time with their family, such as "help take care of your brothers and sisters," "eat meals with your family," and "spend time with your family on weekends."

Family Cohesion and Support. Family cohesion and support were measured using the parent subscale of the Inventory of Parent and Peer Attachment (IPPA; Armsden & Greenburg, 1987). Using a 5-point scale (1=almost never to 5=almost always), participants answered 19 questions indicating to what extent they felt close to and supported by their parents. Example items include, "I could count on my parents when I needed to talk" and "I trusted my parents."

Risk Taking Behavior. A modified version of the Adolescent Risk Taking Scale (Alexander et al., 1990) was used to measure how often adolescents engage in risky behaviors. Adolescents responded to 9 items using a 4-point scale ("never," "once or twice," "several times" and "many times") to indicate the frequency with which they have engaged in the following behaviors: raced on a bike or boat, did something risky or dangerous on a dare, broke a rule that their parents set just for the thrill of seeing if they could get away with it, stole or shoplifted, slipped out at night while their parents thought they were asleep, willingly rode in a car with someone who was a dangerous driver, tagged or defaced public property, drove in a car without wearing a seatbelt, and had sex without using protection.

Decision Making Competence. The Flinders Adolescent Decision Making Questionnaire (Mann et al., 1989) was used to examine adolescents' decision-making strategies. Adolescents responded using a four-point scale (1= "not at all true of me" to 4= "almost always true of me") to six items assessing decision making vigilance (e.g., "I take a lot of care before I make my choice" and "I like to think about a decision before I make it") and six items assessing decision making avoidance (e.g., "I avoid making decisions" and "I put off making decisions"). The avoidance items were reverse scored, and the two subscales were averaged to create a measure of decision making competence.

fMRI Paradigms

Risk Taking Task. To examine neural sensitivity to risk, participants completed the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). Importantly, behavioral performance on the BART correlates with real-life risk behaviors such as adolescent smoking, sexual promiscuity, addiction, and drug use (Lejuez et al., 2003; Bornovalova et al., 2009) suggesting that this task provides a scanner-compatible proxy for measuring real-world behaviors.

On each trial of the task, participants are shown a virtual red-colored balloon and given the option to inflate the balloon, which can either grow larger or explode (see Figure 3.1). The larger the balloon is inflated, the greater the monetary reward but the higher the probability of explosion. Participants press one of two buttons to either inflate (pump) the balloon or to "cash-out." Each trial begins with the presentation of a balloon and ends when the balloon either explodes or the participant cashes out. The participant receives a payoff (25 cents) for each pump on which the balloon is successfully inflated and can stop inflating the balloon at any point and keep the accumulated payoff. If the balloon explodes, the participant receives no payoff for that trial, but earnings from previous trials are unaffected. The number of inflations before explosion is varied probabilistically according to a Poisson distribution. This pattern models the unpredictable rewards and punishments that characterize real-world risky behaviors. As pumping progresses during a trial, explosion probability increases exponentially. The explosion point of each balloon was drawn from a uniform distribution from 1 to 12 pumps. In addition, 25% percent of the balloons were white and were not associated with a reward or possible explosion and provided a control for the visual and motor aspects of pumping. Participants were instructed to “pump” the white balloons until they disappeared. White balloons did not explode but inflated according to the same distribution as the red balloons. After each pump, the balloon image disappeared (1-3 sec, variable duration) until the outcome was displayed: a larger balloon or an exploded one. At the end of each trial, the screen was blank for a varying duration (1-12 sec, average 4 sec). The task was self-paced, and was performed during one 9 minute run. Participants received their total earnings at the end of the task.

Cognitive Control Task. Participants completed a standard Go-NoGo (GNG) Task as a functional localizer to target cognitive control related brain function. Participants were presented with a series of rapid trials (1 second each), each displaying a single letter, and were instructed to respond with a button press as quickly as possible to all letters except for X. The X occurred on 25% of trials. Thus, participants develop a pre-potent response to press (go) upon stimulus onset, and must inhibit the go response on X trials (no-go). Response inhibition was operationalized as successful no-go trials (overriding the pre-potent “go” response) compared to go trials. Participants completed 5 blocks, each of which contained an average of 10 no-go trials and 30 go trials. The inter-trial interval (ITI) was jittered according to a random gamma distribution (M=0.75 seconds). Each block (40 trials and ITIs) lasted 70 seconds, and blocks were separated by twelve-second rest periods.

fMRI Data Acquisition and Analysis

fMRI data acquisition. Imaging data were collected using a 3 Tesla Siemens Trio MRI scanner. The tasks were presented on a computer screen, which were projected through scanner-compatible goggles. The BART task consisted of 270 functional T2*-weighted echoplanar images (EPI) and the GNG task consisted of 200 images [slice thickness, 4 mm; 34 slices; TR = 2 sec; TE = 30 msec; flip angle = 90 degrees; matrix = 64 x 64; FOV = 200 mm; voxel size 3 x 3 x 4 mm^3]. A T2*weighted, matched-bandwidth (MBW), high-resolution, anatomical scan and magnetization-prepared rapid-acquisition gradient echo (MPRAGE) scan were acquired for registration purposes (TR: 2.3; TE: 2.1; FOV: 256; matrix: 192 x 192; sagittal plane; slice thickness: 1 mm; 160 slices). The orientation for the MBW and EPI scans was oblique axial to maximize brain coverage.

fMRI Data Preprocessing and Analysis. Analyses were performed using FSL 4.1.6 (www.fmrib.ox.ac.uk/fsl). All images were skull-stripped using FSL BET. The images were realigned to compensate for small head movements (Jenkinson *et al*, 2002). No participants exceeded > 2 mm in translational movement. Data were smoothed using a 5-mm FWHM Gaussian kernel to increase the signal-to-noise ratio, and filtered in the temporal domain using a nonlinear high-pass filter (100-sec cutoff). EPI images were registered to the MBW, then to the MPRAGE, and finally into standard MNI space (MNI152, T1 2 mm) using linear registration with FSL FLIRT.

One general linear model (GLM) was defined for the BART, which included multiple regressors for each event type: pumps, cash-outs, and explosions. For the pumps, we analyzed the adjusted pumps, which represent the number of pumps on balloons that did not explode. This is preferable to examining pumps on balloons that did explode, because the number of pumps is necessarily constrained on balloons that explode (Lejuez et al., 2002). Pumps, cash outs and explosions were modeled with a parametric regressor that tested for the linear relationship between brain activation and the magnitude of pumps, reward, or loss. We used pump number as a parametric modulator, with each pump in a trial assigned a weight that increased linearly across pumps within a trial. On cash-out trials and explosions, this number represented how many pumps occurred before the cash-out or explosion. The number of pumps was demeaned by subtracting the mean number of pumps from each pump number within the trial. Because the task was self-paced, the duration of each trial represented the RT for that trial. Null events, consisting of the jittered inter-trial intervals, were not explicitly modeled and therefore constituted an implicit baseline.

For the GNG task, one general linear model (GLM) was defined which included multiple regressors for each event type: successful go trials, successful nogo trials, and false alarms. Events were modeled with a 1s duration. The rest periods and jittered inter-trial intervals were not explicitly modeled and therefore served as an implicit baseline. For both tasks, temporal derivatives and motion parameters were included as covariates of no interest for all regressors.

The FSL FEAT package was used for statistical analysis. Regressors of interest were created using a stick function of the event duration at the onset time of each trial with a canonical (double-gamma) HRF. A group-level analysis was performed using the FMRIB Local Analysis of Mixed Effects module in FSL (Beckmann et al., 2003). Thresholded Z statistic images were prepared to show clusters determined by a corrected, cluster-forming threshold of $Z > 2.3$ and an extent threshold of $p < .05$ familywise error corrected using the Theory of Gaussian Random Fields (Poline et al., 1997). Outliers were de-weighted in the multi-subject statistics using mixture modeling (Woolrich, 2008). To examine correlations between reward sensitivity on the

BART, cognitive control on the GNG, and family obligation values, family obligation scores were entered as a regressor in the contrasts of interest. For visualization, statistical maps of all analyses were projected onto a study-specific average brain of the participants.

Results

Behavioral Results

BART. Participants inflated 3.79 (*SD* =1.05) pumps on average ranging from a minimum of 3 pumps to a maximum of 11 pumps. Participants exploded 33.83% (*SD*=9.7) and successfully cashed out on 64.36% (*SD*=10.34) of balloons. Participants took significantly longer to cash out (*M*=0.91 seconds, *SD*=.31) than to inflate balloons (*M*=0.75 seconds, *SD*=.26, $t(47)$=3.69, p=.001), and earned a total of $15.64 (*SD*=4.01) on average (range= $8.25-$26.75). To examine how family obligation relates to behavioral performance on the BART, we conducted regression analyses controlling for gender and age. Adolescents with greater family obligation values had lower mean pumps (β=-.31, p<.05) and earned less money on average (controlling for total number of red balloons; β=-.28, p=.05), suggesting a lower propensity towards risky, reward sensitive behavior. Family obligation was not related to the percent of balloons that were cashed or exploded or to mean response time.

GNG. On average, participants successfully inhibited 83.23% (*SD*=12.92) of the no-go trials (i.e., withheld the button press to the no-go trials), ranging from 40-100%. Participants' mean reaction time was significantly faster to false alarms (*M*=.36 seconds, *SD*=.06) than to successful go trials (*M*=427ms, *SD*=43.83), $t(44)$=8.15, p<.001. Family obligation values were not related to false alarms or mean reaction time.

fMRI Results

Main Effects on the BART. In whole brain analyses, we examined neural activation to pumps, cash outs, and explosions. As shown in Table 3.1a and Figure 3.2a, the contrast used to examine activation associated with increasing pumps (Pumps > Control) revealed activation in dopamine rich neural regions involved in reward processing and risk monitoring as well as frontal regions involved in cognitive control. These included the bilateral ventral striatum, bilateral caudate nucleus, ventral midbrain, bilateral anterior insula, bilateral DLPFC and the dorsal anterior cingulate cortex (dACC). Other significant brain regions included the bilateral temporal parietal junction (TPJ) and cerebellum. The opposite contrast (Control> Pumps) revealed activation in the paracentral gyrus, bilateral inferior insula, ventromedial prefrontal cortex (vmPFC), middle temporal gyrus, and middle frontal gyrus. No brain regions were significantly activated to cash outs or explosions.

Main Effects on the GNG. In whole brain analyses, we examined neural activation to successful response inhibitions (nogo trials). As shown in Table 3.1b and Figure 3.2b, successful response inhibitions (Nogo>Go) activated brain regions involved in cognitive control, including the bilateral DLPFC and dACC. Other significant brain regions included the bilateral anterior insula, inferior parietal lobule, visual cortex, precuneus, and cerebellum. The opposite contrast (Go>Nogo) revealed activation in precuneus, premotor cortex, vmPFC, superior temporal sulcus, bilateral inferior insula, cerebellum, and fusiform gyrus,

Correlations Between Family Obligation and Risk Taking. Next, we examined how family obligation was related to neural regions involved in risk taking . In whole brain regression analyses, we correlated family obligation values with neural activation during pumps, cash outs, and explosions. Age and gender were included as covariates. With increasing pumps (Pumps>Control), family obligation values were positively related to activation in the bilateral fusiform (Table 3.2). Family obligation values were not negatively correlated with any brain regions during pumps. For cash outs, family obligation values were negatively correlated with activation in the bilateral ventral striatum as the number of pumps increased (see Figure 3.3 and Table 3.2). In other words, there was greater VS activation in cash out trials that yielded greater reward value; this activation was negatively associated with family obligation values. No brain regions correlated positively with family obligation values during cash outs. Finally, family obligation values did not relate to neural activation during explosions.

Correlations Between Family Cohesion and Support and Risk Taking. Next, we examined whether family cohesion and support show similar patterns as those found for family obligation values. In whole brain regression analyses, we correlated family cohesion and support with neural activation to pumps, cash outs, and explosions. Family cohesion and support did not correlate with activation during any of these contrasts. Moreover, in whole brain regression analyses controlling for family support, family obligation continues to predict bilateral ventral striatum activation above and beyond the effects of family cohesion and support (Z=3.52, p<.05, corrected).

Correlations Between Family Obligation and Behavioral Inhibition. Next, we examined how family obligation related to neural response during behavioral inhibition by examining activation to Nogo>Go trials on the GNG. In whole brain regression analyses controlling for age and gender, family obligation values were positively correlated with activation in the left dorsolateral prefrontal cortex (DLPFC; see Figure 3.4 and Table 3.3). No brain regions correlated negatively with family obligation values.

Correlations Between Family Cohesion and Support and Behavioral Inhibition. We examined whether family cohesion and support show similar patterns as those observed for family obligation values. In whole brain regression analyses, we correlated family cohesion and support with neural activation to successful behavioral inhibitions (Nogo>Go). Family cohesion and support did not correlate with neural activation during Nogo>Go trials. In whole brain regression analyses controlling for family cohesion and support, family obligation continues to predict DLPFC activation to behavioral inhibitions above and beyond the effects of family cohesion and support (Z=3.89, p<.05 corrected).

Linking Neural Activation to Real-Life Risk Taking and Decision Making. Finally, we examined how percent BOLD signal change in the VS to increasing rewards relates to adolescents' risk taking and how percent BOLD signal change in the DLPFC to behavioral inhibitions relates to decision making. We extracted the percent BOLD signal change in the VS to cash out trials from the cluster that correlated with family obligation values and regressed it onto deviant behavior and risk taking in SPSS. Controlling for age and gender, decreased ventral striatum activation to cash out trials was associated with less risk taking behavior (right VS: B=1.50, SE=.49, β=.43, p<.005; left VS: B=1.15, SE=.54, β=.32, p<.05; Figure 3.5a).

For decision making competence, we extracted percent BOLD signal change in the DLPFC to successful behavioral inhibitions (i.e., nogo-go trials) from the cluster that correlated with family obligation and regressed it onto decision making competence in SPSS. Controlling for age and gender, DLPFC activation to nogo-go trials was associated with better decision making competence (B=5.50, SE=1.42, β=.53, p<.001; Figure 3.5b).

Discussion

Vulnerability to risk taking during adolescence is normative and arises, in part, because of changes in the brain's neural circuitry. Discordant development of brain regions responsible for cognitive control and reward processing may render adolescents more susceptible to emotionally driven, reward-seeking behaviors and less able to modulate such decisions (Sommerville et al., 2010; Steinberg, 2008). Although prior work has highlighted how social relationships may amplify this vulnerability (Chein et al., 2010), no prior work has examined whether social relationships can decrease neural vulnerability to adolescent risk taking. Identifying ways to reduce the neural imbalance during adolescence can have important implications for risk taking and associated health outcomes. Accordingly, we sought to examine how a key family relationship – family obligation – can reduce this vulnerability. Previous reports had shown that increased family obligation is associated with decreased risk taking (e.g., German et al., 2009; Gil et al., 2000; Kaplan et al., 2001; Ramirez & de la Cruz, 2003), but the neural mechanism underlying this relationship remained elusive. Our results suggest that family obligation may alter activation in neural regions involved in reward sensitivity and cognitive control, and activation in these neural regions is associated with adolescents' real life risk taking behaviors and decision making skills.

Family obligation values were associated with decreased pumps on the BART as well as less money earned overall. The more participants are willing to inflate the balloons during this task, the greater risk level they are willing to take. Therefore, the average number of inflations represents an objective assessment of risk preference (Rao et al., 2008). Thus, participants with higher family obligation values pumped the balloons to a lesser extent, suggesting they have a lower risk preference. In addition, family obligation values were related to dampened activation in the ventral striatum to increasing monetary rewards. The ventral striatum is typically associated with reward sensitivity and approach-related behavior (Delgado et al., 2000; Knutson et al., 2000). Together, these behavioral and neural results suggest that adolescents who value family obligation to a greater extent are less oriented to risky decisions (i.e., greater risk aversion) and have a lower sensitivity to reward.

The task design of the BART precludes our ability to delineate the specific processes that may be involved during cash out trials. These decisions may involve reward sensitivity, such that adolescents cash out in order to gain increasing monetary rewards, or these decisions may involve risk aversion, such that adolescents cash out in order to avoid an explosion and lose a potential monetary gain. Thus, the effects of risk and reward are confounded in this study. Future studies should attempt to dissociate how risk and reward are processed independently of one another.

Family obligation values were also associated with greater activation in the DLPFC during successful behavioral inhibition. Prior work has found that adults recruit the lateral PFC to a greater extent than adolescents during risk taking (Chein et al., 2010; Eshel et al., 2007), and children show decreased activation in the lateral PFC compared to adults when matched on performance during a cognitive control task (Bunge et al., 2002). Together, these studies suggest that increased DLPFC activation is suggestive of more mature cognitive control. Adolescence is characterized as a period of high reward seeking behaviors in the context of relatively immature self-regulatory skills (Somerville et al., 2010). We speculate that in our study, the more “mature” use of the DLPFC during the cognitive control task may render adolescents with higher family obligation better able to regulate emotionally driven behaviors, thereby reducing risk taking.

Family obligation is a unique aspect of family relationships that relates to reduced risk taking behavior above the effects of family cohesion and support. Individuals who more strongly value helping others and putting others' needs before their own are more likely to assign priority to another's welfare and regulate their own behavior and emotions in order to meet another's needs (Caprara and Steca 2007). Indeed, adolescents who value family obligation often put the needs of their family before their own, consider the needs of their family when making important life decisions, and think about their family's needs and wishes for the future (Fuligni, Tseng, & Lam, 1999). Moreover, decisions to assist one's family recruit neural regions involved in cognitive control (Telzer et al., 2011). Thus, family obligation provides adolescents opportunities to engage in and practice self control. In addition, adolescents who value family obligation report more negative consequences for engaging in risky behavior (German et al., 2009), and so these adolescents may find risk taking to be comparatively less rewarding. Interestingly, family cohesion and support itself was not associated with neural activation during risk or cognitive control, suggesting that it is not simply about having a close and supportive family that reduces neural sensitivity to risk. Rather, the independent predictive value of family obligation suggests the results are due to specific types of family relationships that foster self-regulatory skills and an avoidance of behaviors that could have negative consequences.

If dampened VS activation during the BART is suggestive of reduced reward sensitivity and risk aversion, and increased DLPFC activation during the GNG is suggestive of more mature decision making skills, these neural activations should also be associated with adolescents' real-life risk taking and decision making. Indeed, we find that dampened VS activation is associated with less self-reported risk taking and deviant behaviors. Thus, family obligation relates to dampened VS activation, and this dampened VS activation relates to less real life risky behavior. In addition, adolescents who show greater DLPFC activation report better decision making competence, corroborating that enhanced DLPFC activation is indicative of more mature use of this region, relating to better decision making skills. These findings support that family obligation may reduce neural sensitivity to risk taking behavior and are consistent with other studies showing that heightened DLPFC and dampened VS activation are associated with lower risk taking behaviors in adolescents (Galvan et al., 2007; Ernst et al., 2006; Eshel et al., 2007).

Although not the primary purpose of this study, we found that increasing risk during the BART (i.e., increasing pumps) was associated with robust neural activity in the mesolimbic-frontal pathway, including the striatum, ventral midbrain, insula, dACC and DLPFC. These activations are consistent with those of Rao and colleagues (2008) who used a modified version of the BART among adults. Interestingly, explosions and cash-outs did not recruit any brain regions in the main effects. Perhaps this is because these contrasts are modulated by individual differences. Indeed, neural response to the cash out trials was modulated by family obligation, such that only individuals with the lowest values showed heightened activation in the ventral striatum. Future research should attempt to understand what individual differences among adolescents predict neural sensitivity to punishment (explosions) and rewards (cash outs).

We examined an aspect of family life that is culturally relevant to Mexican families. By taking this approach, we were able to identify a “cultural resource” for these adolescents, identifying how family obligation can be a protective factor. We believe these findings apply to youth from diverse cultural backgrounds. By engaging in social relationships that allow adolescents to put the needs of others before their own, by engaging in self control, and attaining a sense of meaning from the relationship, adolescents may develop the skills and resources needed to avoid risk taking. Future research should examine how other social relationships, such as participating in community service, engaging in positive peer relationships such as academic clubs, and religious engagement can similarly reduce risk taking among diverse adolescents.

Figure 3.1. The BART has 3 types of conditions: a) red balloons in which the participant inflated the balloon until it exploded, b) red balloons in which the participant inflated and successfully cashed out, and c) white balloons that are not associated with a monetary reward.

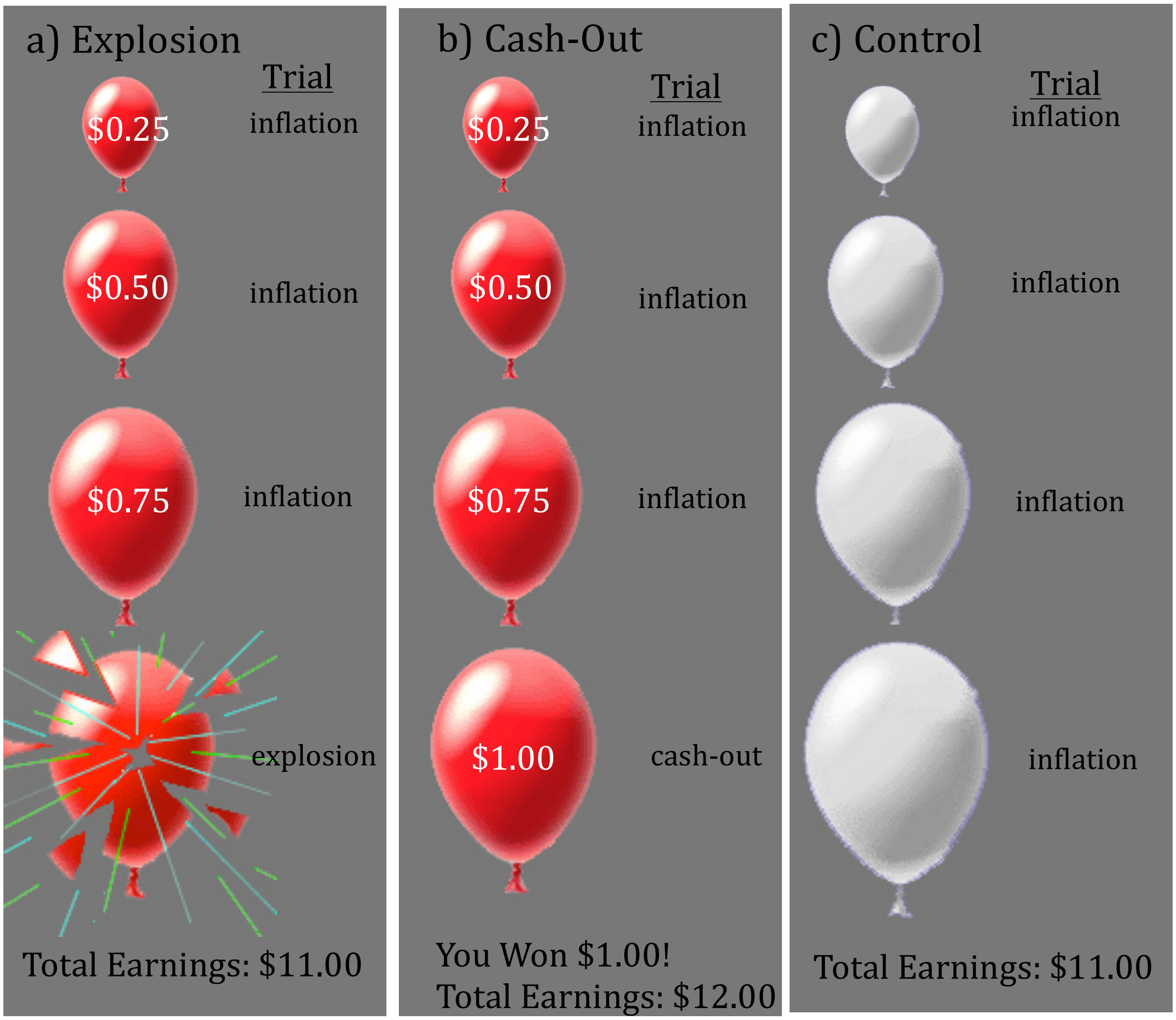

Figure 3.2. Main effects on the (a) BART to pumps>control and (b) GNG to Nogo>Go

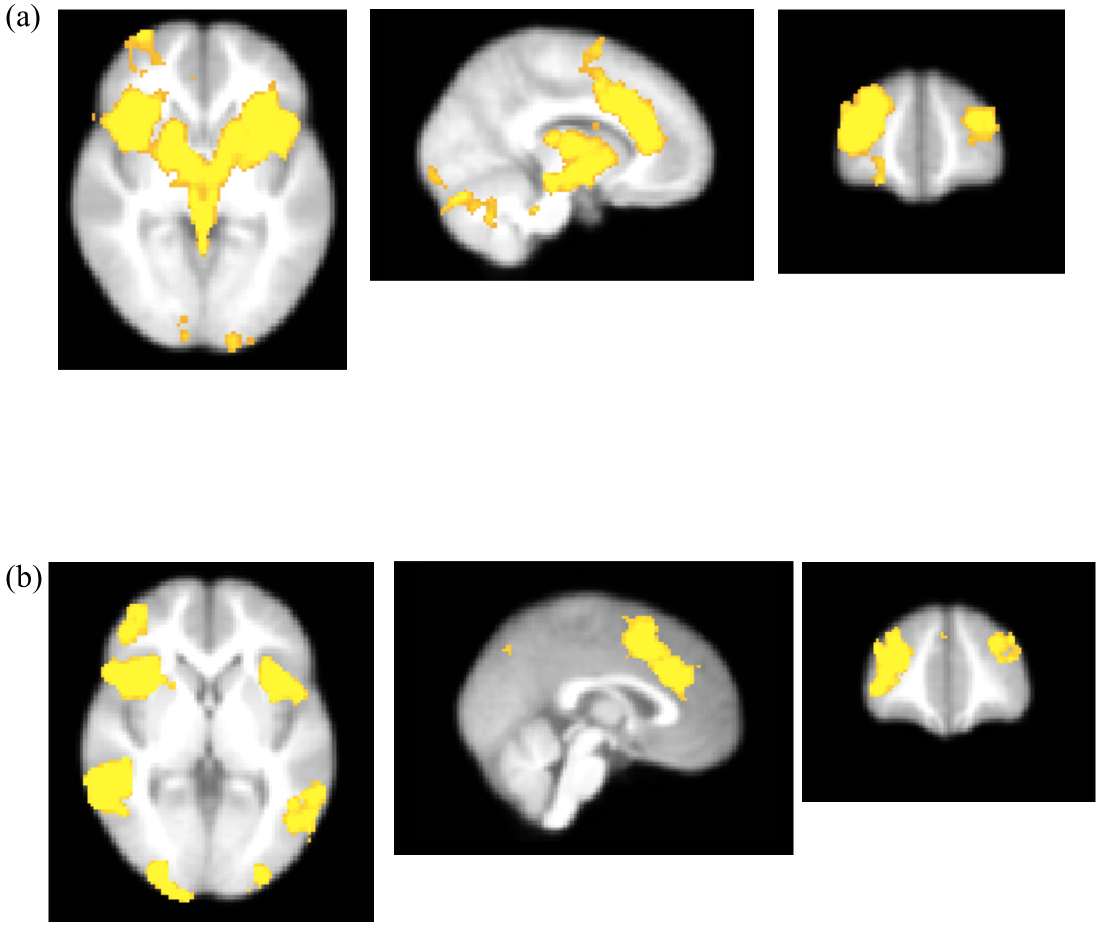

Figure 3.3. Percent signal change in the ventral striatum to cash-outs that correlated with family obligation values.

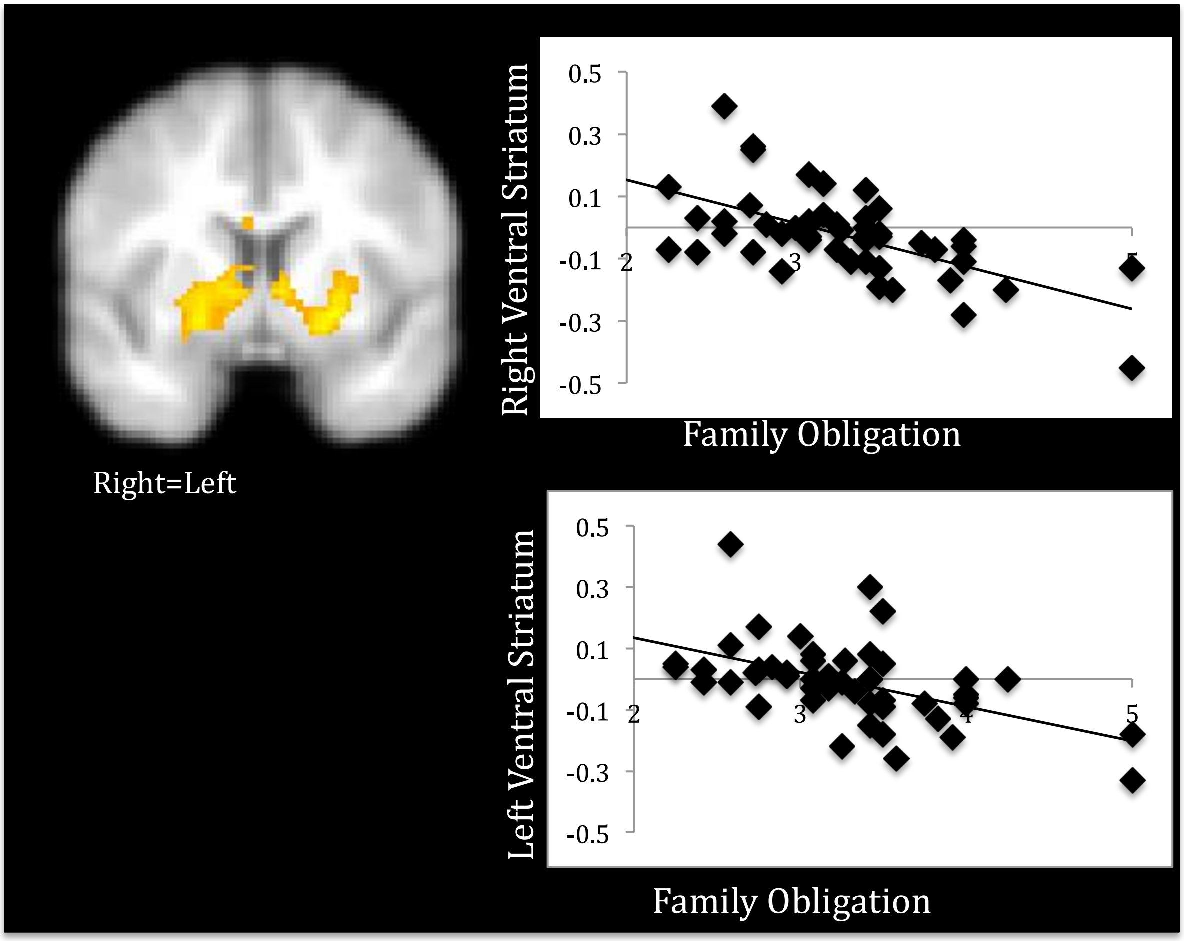

Figure 3.4. Percent BOLD signal change in the DLPFC during behavioral inhibitions that correlated with family obligation values.

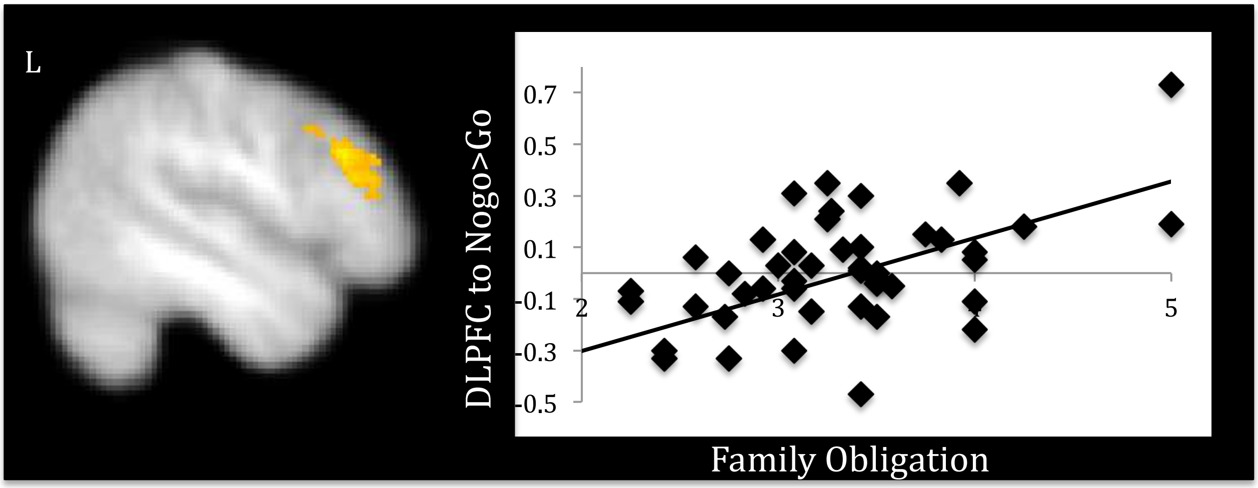

Figure 3.5. Percent BOLD signal change in (a) the VS that correlated with risk taking and (b) the DLPFC that correlated with decision making skills

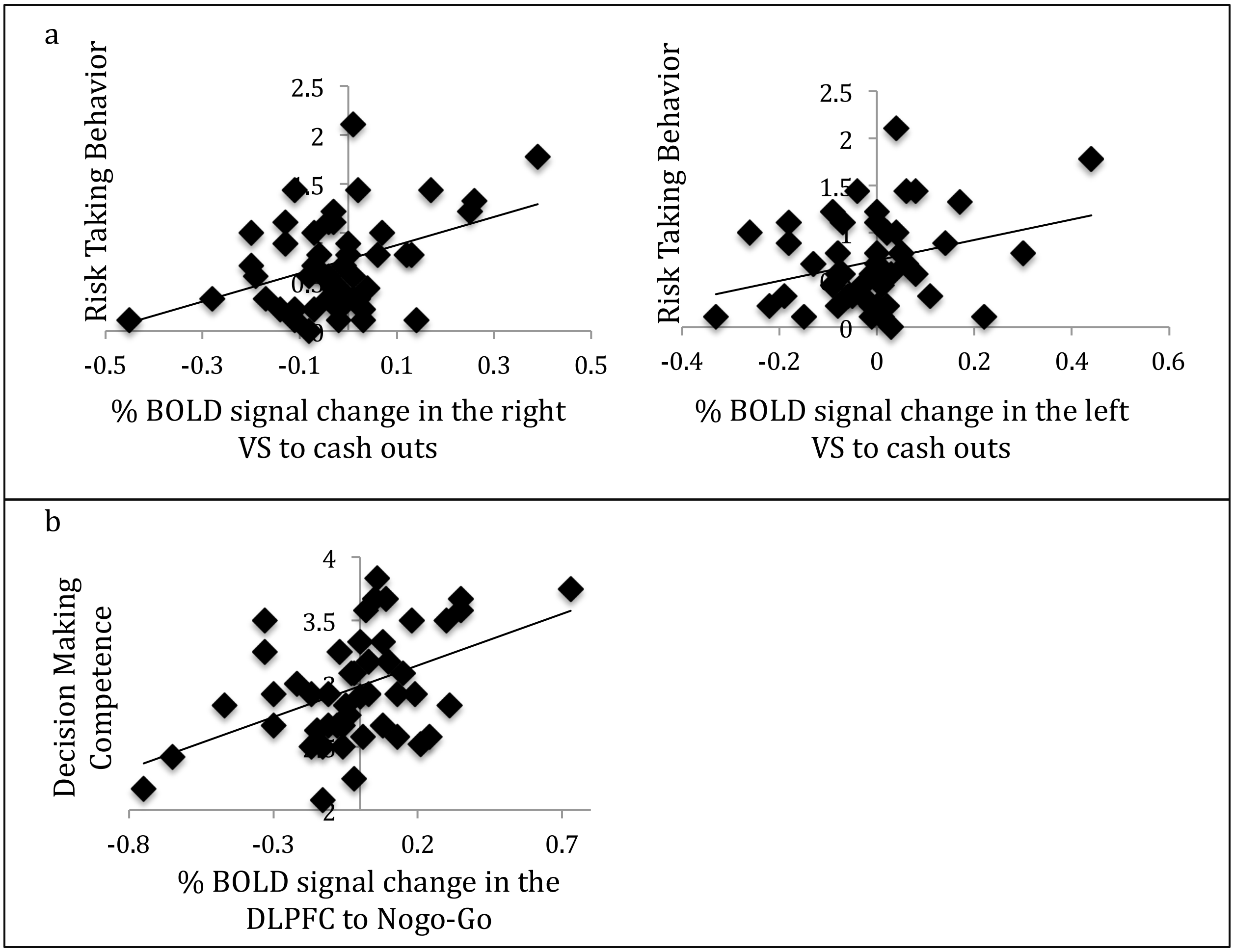

Table 3.1. Neural Regions Activated During (a) Risk Taking and (b) Response Inhibition

Contrast	Anatomical Region	x	y	z	*Max Z*	*k*
(a) Risk Taking						
Pumps>Control						
	R anterior insula	38	18	2	7.80	37,798[a]
	L anterior insula	-36	18	6	6.20	[a]
	dACC	-2	20	38	7.41	[a]
	R VS	19	8	-6	4.50	[a]
	L VS	-14	6	-4	4.07	[a]
	R DS	16	4	14	4.06	[a]
	L DS	-18	6	12	4.02	[a]
	R DLPFC	30	52	28	5.29	[a]
	L DLPFC	-30	48	20	4.81	[a]
	R cerebellum	26	-50	-26	5.52	[a]
	L cerebellum	-36	-56	-34	5.69	[a]
	ventral midbrain	2	-18	-16	5.48	[a]
	R inferior parietal cortex	42	-48	40	5.04	2,169
Control>Pumps						
	R paracentral lobule	22	-28	72	6.20	31,325[b]
	R inferior insula	42	-16	16	4.70	[b]
	R middle temporal gyrus	44	-80	16	4.50	[b]
	L middle temporal gyrus	-50	-64	20	4.58	[b]
	orbital frontal cortex	6	24	-14	5.89	3,326[c]
	L middle frontal gyrus	-32	8	54	4.2	[c]
(b) Response Inhibition						
Nogo>Go						
	R anterior insula	28	20	-10	6.15	11,198[d]
	R DLPFC	36	48	22	3.89	[d]
	dACC	6	30	28	4.37	[d]
	R inferior parietal cortex	58	-44	34	6.78	7,623
	L inferior parietal cortex	-60	-38	28	6.36	3,463
	L anterior insula	-34	18	6	5.30	1,265
	L DLPFC	-32	52	16	4.09	857
	R visual cortex	28	-94	-6	6.30	754
	R precuneus	10	-68	40	4.81	621
	L visual cortex	-30	-96	-6	5.37	577
	L cerebellum	-34	-60	-28	3.84	528
Go>Nogo						
	precuneus	-4	-54	6	6.08	13,182[e]

premotor cortex	0	-36	58	4.2	[e]
orbital frontal cortex	2	40	-20	6.06	6,580
L superior temporal sulcus	-62	-10	-16	4.76	1,485[f]
L inferior insula	-48	-14	16	3.82	[f]
L cerebellum	64	-6	6	4.56	600
R inferior insula	14	-88	-38	5.06	483
L fusiform gyrus	-54	-48	-14	4.28	461

Note. L and R refer to left and right hemispheres; x, y, and z refer to MNI coordinates; *Max Z* refers to the z-score at those coordinates (local maxima); *k* refers to the number of voxels in each significant cluster. A Anatomical regions that share functional clusters are denoted with the same superscript letter. ll regions are listed at cluster-forming threshold of $Z > 2.3$ and an extent threshold of $p < .05$ corrected using the Theory of Gaussian Random Fields. The following abbreviations were used for the specific brain regions: dACC=dorsal anterior cingulate cortex; VS=ventral striatum; DS=dorsal striatum; DLPFC=dorsolateral prefrontal cortex.

Table 3.2. Neural Regions That Correlated Negatively with Family Obligation Values during Cash-Out Trials that Increased Parametrically According to the Amount of Reward

Anatomical Region	x	y	z	*Max Z*	*k*
Right VS	20	10	-8	4.04	697
Left VS	-6	8	0	3.72	565
Right Cuneus	-20	-104	2	3.79	38
Left Cuneus	6	-106	16	3.44	509

Note. x, y, and z refer to MNI coordinates; *Max Z* refers to the z-score at those coordinates (local maxima); *k* refers to the number of voxels in each significant cluster. All regions are listed at cluster-forming threshold of $Z > 2.3$ and an extent threshold of $p < .05$ corrected using the Theory of Gaussian Random Fields. VS refers to the ventral striatum.

Table 3.3. Neural Regions That Correlated Positively with Family Obligation Values during Behavioral Inhibition on the Go-Nogo Task

Anatomical Region	x	y	z	*Max Z*	*k*
Left DLPFC	-20	58	32	4.05	1943
Left Precuneus	-6	-64	42	3.44	557

Note. x, y, and z refer to MNI coordinates; *Max Z* refers to the z-score at those coordinates (local maxima); *k* refers to the number of voxels in each significant cluster. All regions are listed at cluster-forming threshold of $Z > 2.3$ and an extent threshold of $p < .05$ corrected using the Theory of Gaussian Random Fields. DLPFC refers to the dorsolateral prefrontal cortex.

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Chapter 4

Ventral Striatum Activation to Prosocial Rewards

Predicts Longitudinal Declines in Adolescent Risk Taking

Adolescence is a time of heightened reward sensitivity, an orientation towards excitement and arousal, and the development of motivated behaviors and passions (Dahl, 2004; Ernst et al., 2009). These emotions can be both positive and negative for adolescents' health, creating vulnerabilities as well as opportunities to transform these emotions into positive goals (Dahl, 2004). For instance, adolescents may direct these emotions towards problematic activities, such as drug experimentation, engagement with deviant peers, risky sexual behaviors, school truancy, and reckless driving. On the other hand, adolescents may direct these emotions towards positive, goal-directed behaviors, such as after-school sports, religious participation, prosocial behaviors, hobbies, and healthy peer and romantic relationships.

Several recent models of brain development offer converging support that neural systems important in detecting motivationally and emotionally relevant cues in the environment undergo massive remodeling during adolescence (Casey et al., 2011; Nelson et al., 2005; Ernst et al., 2009; Steinberg, 2008). The socioemotional system, which comprises neural regions associated with the evaluation of rewards (e.g., ventral striatum (VS)), matures relatively early, and this is thought to lead to increased reward seeking during adolescence (Somerville et al., 2011; Steinberg, 2008). Neurobiological evidence from both rodent and human studies indicates that the remodeling of the socioemotional system around the time of adolescence is associated with increased sensitivity to rewarding stimuli relative to both children and adults (Anderson et al., 2000; Brenhouse et al., 2008; Douglas et al. 2003; Teicher, Andersen & Hostetter, 1995; Ernst et al., 2005; Galván et al., 2006; Van Leijenhorst et al., 2010).

The relatively early development of the socioemotional system has largely been suggested to create vulnerabilities, contributing to the high rate of problem behaviors during adolescence. Significant work has examined how heightened reward sensitivity may underlie adolescent risk taking. For example, Galván and colleagues found that adolescents show heightened VS activation to rewards relative to both children and adults (Galván et al., 2006). Moreover, VS activation to reward anticipation was associated with increased likelihood of engaging in risky behavior such as illicit drug use, heavy drinking, and illegal behaviors (Galván et al., 2007). Together, these results suggest that adolescents are more behaviorally and neurobiologically sensitive to rewarding stimuli, and this sensitivity is associated with real-life risk taking behaviors. These studies, among others (e.g., Steinberg, 2010; Chein et al., 2011; Van Leijenhorst et al., 2010), support the notion that heightened reward sensitivity during adolescence may contribute to risk taking during this developmental period.

In contrast, relatively little work has examined how heightened reward sensitivity can create opportunities for adolescents. If adolescents direct their emotions and motivations towards positive goal-directed behaviors, such as prosocial activities, heightened reward sensitivity may potentially be an asset. Efforts to achieve a goal can activate high intensity, rewarding feelings that also engage the reward system but may not lead to bad outcomes (Dahl, 2004). Therefore, the very same neural regions that create vulnerabilities for adolescents may also be protective against risk taking if engaged in a positive way. For example, neuroimaging research in adults has found that prosocial behaviors engage the VS even more so than do personal rewards, suggesting that helping others is a meaningful and rewarding experience (Harbaugh et al., 2007; Izuma et al., 2009; Moll et al., 2006). This heightened reward sensitivity to others' gains may be one way that VS activation could be positive and lead to healthy outcomes in adolescence.

Helping the family is a salient and frequent type of prosocial behavior among adolescents, often occurring on a daily basis. For instance, 98% of adolescents from diverse cultural and economic backgrounds report helping their family on a weekly basis (Telzer &

Fuligni, 2009). Families from Latin American backgrounds place particular emphasis on the importance of high family unity, family social support, and interdependence for daily activities (Cuellar et al, 2005). Because of these cultural values, adolescents from Mexican backgrounds are often motivated to help their family, spending more than twice as much time helping their family each day than their peers from European backgrounds (Telzer & Fuligni, 2009).

Participating in a daily routine, such as family assistance, that is meaningful with respect to group goals and values builds confidence and leads to enhanced well being (Weisner, Matheson, Coots, & Bernheimer, 2005). Indeed, we have found that adolescents who assist their family and feel that they are fulfilling important roles within their family, such as that of a good family member, have better physical and psychological well being (Fuligni et al., 2009; Telzer & Fuligni, 2009). Moreover, at the neural level, decisions to help the family engage brain regions involved in reward processing. For example, when making personal sacrifices for one's family, adolescents who report a greater sense of meaning and fulfillment from helping their family show greater activation in the ventral striatum (Telzer et al., 2010). Thus, family relationships that are personally meaningful provide adolescents with a sense of reward, and this reward may be protective and lead to positive, healthy outcomes.

The increase in intense motivations and passions in adolescence can be channeled into a range of behaviors (Dahl, 2004). On the one hand, if directed towards problematic activities, such as drug experimentation and engagement with deviant peers, this heightened reward sensitivity may be a vulnerability. On the other hand, if directed towards meaningful activities, such as providing assistance to one's family, this heightened reward sensitivity may be a source of protection, reducing susceptibility to risky behavior. In the current study, our first goal was to examine how neural activation to prosocial rewards relates to adolescent risk taking behavior.

Adolescents were followed over a one-year period to examine whether VS activation to prosocial rewards at Time 1 predicts decreases in risk taking behavior over the following year.

The second goal of this study was to examine whether neural activation to prosocial rewards predicts longitudinal changes in risk taking behavior above and beyond adolescents' self-reports of their likelihood of engaging in risky behavior over the year. Although self-reported intentions predict some variability in future risk-taking behavior (Wolford & Swisher, 1986), evidence also suggests that self-reports are not sufficient to capture the multidimensional nature of risk taking (Aklin et al., 2005). Perhaps this is because adolescents may lack the insight or cognitive ability to provide an accurate report of their own intentions (Aklin et al., 2005). Thus, implicit processes may explain variability in behavior change that is not explained by self-reported measures such as attitudes and intentions (Falk et al., 2010). Therefore, in the current study, we measure neural activation to prosocial rewards as well as adolescents' intentions to engage in risky behavior in the following year to examine whether VS activation predicts longitudinal changes in risk taking above and beyond adolescents' self-reported intentions. Examining neural activity in conjunction with self-reported intentions will help us to gain a deeper understanding of brain-behavior relationships over time.

Methods

Participants

At the first time point, forty-eight adolescents from Mexican-American backgrounds participated in an fMRI scan during which they completed a family contribution task. Participants completed a self-report measure of their risk taking behaviors as well as the likelihood of engaging in risky behaviors in the next year (see below). Of the 48 participants who were scanned, 8 were excluded due to incomplete data (i.e., did not accept enough trials during the family contribution task for statistical analysis (*N*=7); did not complete the self report measures (*N*=1)). Approximately one year following the scan (*M*=10.08 months, *SD*=1.07), participants completed the self-report measure of their risky behaviors again. Our final sample consisted of 32 participants who provided self-report ratings again at Time 2.

At Time 1, participants were in the 10^{th} or 11^{th} grades and ranged in age from 15-17 years (M_{age}=16.3; 14 males, 18 females). At Time 2, participants were in the 11^{th} or 12^{th} grades and ranged in age from 16-18 (M_{age}=17.1). All but one participant spoke and read English fluently. For the Spanish-speaking participant, all tasks and questionnaire measures were described and administered in Spanish. Participants completed written consent and assent in accordance with UCLA's Institutional Review Board.

Questionnaire Measures

Risky Behavior. Risky behavior was assessed with the Rule-Breaking subscale of the Youth Self-Report form of the Child Behavior Checklist (Achenbach, 1991). At both time points, adolescents rated 111 items on a 3-point scale (0=not true of me, 1=somewhat or sometimes true of me, 2= true or often true of me). The Rule-Breaking subscale includes 16 items that capture a range of risky behaviors, such as associating with deviant peers, lying, stealing, drinking alcohol without parental approval, using drugs, and skipping school.

Participants' scores at Time 1 reflect their concurrent risky behavior at the time of the fMRI scan. Scores at Time 2, after controlling for Time 1, reflect changes (increases or decreases) in participants' risky behavior during the one year following the scan. To control for scores at Time 1, residualized scores for Time 2 were calculated, whereby the group-level variance in Time 2 scores that was explained by Time 1 scores was removed.

Risky Behavior Likelihood. At Time 1, adolescents completed the Cognitive Appraisal of Risky Events (CARE) Questionnaire (Fromme et al., 1997). Participants answered 30 questions on a 7-point scale (1= not at all likely to 7=extremely likely) indicating the likelihood that they will engage in risky behaviors in the next year. The CARE asks about risky behavior in the following domains: illicit drug use (e.g., smoking marijuana), aggressive and illegal behaviors (e.g., driving after drinking alcohol, making a scene in public), risky sexual behaviors (e.g., sex without protection against pregnancy or sexually transmitted diseases), heavy drinking (e.g., drinking alcohol too quickly), academic/work behaviors (e.g., missing class or work), and high risk sports (e.g., rock or mountain climbing). An index of risky behavior likelihood was calculated for each participant by taking the mean of all items except those regarding high risk sports, as these behaviors are not represented in the CBCL.

fMRI Paradigm

We created a family assistance task modeled after the work of Moll and colleagues on charitable giving (Moll, et al., 2006). Prior to the scan, participants were trained on the task. Participants could earn money for themselves and their families by responding to a series of financial offers. Using a handheld buttonbox, participants accepted or rejected offers that varied in terms of whether they represented gains or losses for the participants and their families (see Figure 4.1). Specifically, there were 4 types of offers that were presented to participants: (1) Noncostly-Rewards, in which participants earned money without a cost to the family (e.g., YOU +$3.00 FAM -$0.00); (2) Noncostly-Donations, in which the family earned money without a cost to the participant (e.g., YOU +$0.00 FAM + $3.00); (3) Costly-Rewards, in which the participant earned money at a cost to the family (e.g., YOU +$3.00 FAM -$1.00); and (4) Costly-Donations, in which the family earned money at a cost to the participant (e.g., YOU -

$1.00 FAM +$3.00). The financial values of the offers ranged from -$3.00 to +$7.00 to reduce heuristic responding and fatigue (Andreoni & Miller, 2002; Harbaugh, et al., 2007). The costly trials varied in terms of the ratio of the amount of gain to the amount of loss in order to vary the difficulty of the decisions and obtain a wider range of individual differences in responses. The gain, however, was always greater than the loss.

Participants completed 56 unique payment trials, each presented once per run, totaling 112 payment trials. The costly donation trials were presented 40 times total, and the other conditions were presented 24 times total. In addition there were 24 trials to control for the visual and motor aspects of the task, in which YOU and FAM were presented without a financial gain or loss. For these control trials, participants were instructed to press either button, and it would not affect their endowments. Trial order was randomized for each participant. Each payment offer was presented for 3 seconds, followed by a fixation for an inter-trial period that was jittered lasting 3 seconds on average. Participants were not shown the running total of their own or their family's earnings. At the end of the experiment, participants and their family were paid their earnings in cash.

Our analyses focused on the contrast between the Costly-Donation and Noncostly-Reward trials. Doing so allowed us to focus on neural activation when making a donation to the family that involves self-sacrifice, a behavior that most closely approximates prosocial behavior and generosity. Costly-Donation trials were contrasted to pure cash gains for oneself, which have been shown to be a hedonistically rewarding experience that is associated with activation in the mesolimbic reward system (Moll, et al., 2006).

fMRI Data Acquisition and Analysis

fMRI data acquisition. Imaging data were collected using a 3 Tesla Siemens Trio MRI scanner. The task was presented on a computer screen, which was projected through scanner-compatible goggles. The Family Contribution task consisted of 342 functional T2*-weighted echoplanar images (EPI) [slice thickness, 4 mm; 34 slices; TR = 2 sec; TE = 30 msec; flip angle = 90 degrees; matrix = 64 x 64; FOV = 200 mm; voxel size 3 x 3 x 4 mm^3]. A T2*weighted, matched-bandwidth (MBW), high-resolution, anatomical scan and magnetization-prepared rapid-acquisition gradient echo (MPRAGE) scan were acquired for registration purposes (TR: 2.3; TE: 2.1; FOV: 256; matrix: 192 x 192; sagittal plane; slice thickness: 1 mm; 160 slices). The orientation for the MBW and EPI scans was oblique axial to maximize brain coverage.

fMRI Data Preprocessing and Analysis. Neuroimaging data were preprocessed and analyzed using Statistical Parametric Mapping (SPM8; Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). Preprocessing for each participant's images included slice-timing to adjust for temporal differences in slice acquisition within each volume and spatial realignment to correct for head motion (no participant exceeded 2mm). The realigned and slice-timing-corrected functional data were coregistered to the high resolution MPRAGE, which was then segmented into cerebrospinal fluid, grey matter, and white matter. The normalization transformation matrix from the segmentation step was then applied to the functional and structural images, thus transforming them into standard stereotactic space as defined by the Montreal Neurological Institute and the International Consortium for Brain Mapping. The normalized functional data were smoothed using an 8mm Gaussian kernel, full width at half maximum, to increase the signal-to-noise ratio.

Whole brain statistical analyses were performed using the general linear model in SPM8. Each trial was convolved with the canonical hemodynamic response function. High-pass temporal filtering with a cutoff of 128 seconds was applied to remove low-frequency drift in the time series. Serial autocorrelations were estimated with a restricted maximum likelihood algorithm with an autoregressive model order of 1. The task was modeled as an event-related design. Linear contrasts comparing Costly-Donations (CD) to Noncostly-Rewards (NCR) were calculated for each participant. Events were modeled with a 3s duration beginning with the appearance of the payment screen.

The individual subject contrasts were submitted to random-effects, group-level analyses. The following analyses were run at each voxel across the entire brain volume: (1) regression analyses examining how neural activation during costly contributions (CD>NCR) relates to concurrent risky behaviors at Time 1 (2) regression analyses examining how neural activation during costly contributions (CD>NCR) is associated with longitudinal changes in risky behaviors at Time 2, controlling for Time 1 scores, and (3) regression analyses examining how neural activation during costly contributions (CD>NCR) is associated with longitudinal changes in risky behaviors at Time 2, controlling for Time 1 risky behavior and Time 1 risky behavior likelihood. This final analysis examines whether neural activation to family contributions predicts changes in risky behavior over the next year, above and beyond the effects of adolescents' own view of their likelihood of engaging in risky behavior over the next year.

To correct for multiple comparisons, we conducted a Monte Carlo simulation implemented using 3dClustSim in the software package AFNI (Ward, 2000). Results of 3dClustSim indicated a voxel-wise threshold of $p<.005$ combined with a minimum cluster size of 35 voxels for the whole brain, corresponding to $p<.05$, False Discovery Rate (FDR) corrected.

Results

Behavioral Results

We did not find evidence of normative changes in risk taking behavior from Time 1 (*M*=5.53, *SD*=3.42) to Time 2 (*M*=5.69, *SD*=3.89), $t(31)=.28$, ns as indexed by the CBCL. Risky behaviors at Time 1 were correlated with risky behaviors at Time 2, $r=.64$, $p<.001$. However, there was variability in this association, such that some adolescents' risk taking declined whereas others' increased. The residualized scores for Time 2 risk taking show values that range from -5.12 (decline in risk taking) to 6.94 (increase in risk taking). Risky behavior likelihood (measured using the CARE) was correlated with risky behaviors at Time 1 ($r=.61$, $p<.001$) and risky behaviors at Time 2 ($r=.54$, $p<.005$).

Participants accepted significantly more Noncostly-Rewards (*M*=97.13% of offers, *SD*=4.90) than Costly-Donations (*M*=61.88% of offers, *SD*=23.14) on the family assistance task, $t(31)=8.40$, $p<.001$, suggesting that participants were sensitive to the different conditions. These acceptance rates are similar to those found among older adolescents with a modified version of the same task (Telzer et al., 2010; 2011). Participants took longer to make decisions to accept Costly-Donations (*Mrt* = 1.49s, *SD*=.39) than Noncostly-Rewards (*Mrt* = 1.18s, *SD*=.25), $t(31)=5.81$, $p<.001$. Risky behavior at Time 1 and Time 2 were not related to adolescents' acceptance rates or mean reaction time for either condition.

fMRI Results

Our first analyses examined the main effects of CD and NCR reward trials on brain activation. Whole-brain analyses comparing each condition to control trials show that both CD and NCR trials activate the VS (see Table 4.1). Significant differences emerged in the dACC, ventral midbrain, anterior insula, and cuneus for CD>NCR, and in the inferior insula and fusiform gyrus for NCR>CD.

Next, we examined whether variability in neural activation during costly contributions to the family (CD>NCR) relates to concurrent risky behaviors at Time 1. Time 1 risky behaviors were entered as a regressor in whole brain regression analyses. No brain regions were significantly associated with Time 1 risky behaviors.

Next we examined whether variability in neural activation during costly contributions to the family relates to longitudinal changes in risky behaviors. The residualized scores for Time 2 risky behavior, controlling for Time 1 risky behavior, were entered in whole brain regression analyses. Results show that the ventral striatum was significantly associated with decreases in risky behaviors (see Figure 4.2). No other brain regions were associated with changes in risk taking. Thus, the extent to which adolescents show increased activation in the VS when contributing to their family, the lower their risky behaviors are over the next year, as depicted in the bottom right quadrant of Figure 4.2. Moreover, the extent to which adolescents show increased activation in the VS to personal rewards (NCR>CD), the greater their risky behaviors increase over the next year, as depicted in the top left quadrant of Figure 4.2.

Finally, we entered Time 1 risk behavior likelihood as a covariate to examine whether ventral striatum activation to family contributions predicts declines in adolescents' risk taking above and beyond their own attitudes and intentions. Results show that the ventral striatum continues to predict decreases in risk taking over time (x y z = -9 17 -2, $t(30)=2.97$, $p<.005$, corrected, 43 contiguous voxels).

Discussion

Adolescence is a period of intensified emotions and an increase in motivated behaviors and passions (Dahl, 2004). Evidence from developmental neuroscience suggests that this heightened emotionality occurs because of changes in the brains neural circuitry. The relatively early maturation of the socioemotional system renders adolescents more oriented towards reward-seeking behaviors (Casey et al., 2011; Steinberg, 2008). This orientation to reward can be directed towards adaptive, positive behaviors (e.g., prosocial behaviors) or maladaptive, health compromising behaviors (e.g., sensation seeking and risky taking). Most prior work has focused on how these neural changes may create vulnerabilities for adolescence, leading to increases in risk taking during this developmental period. In the current study, we show that heightened reward sensitivity in the context of meaningful, prosocial behaviors relates to longitudinal *declines* in adolescent risk taking. Therefore, the very same neural regions that have conferred vulnerability for adolescent risk taking may also be protective against this behavior.

Our findings suggest that VS activation may represent an individual difference in the importance and rewarding nature of family assistance. The more meaning individuals gain from providing assistance to their family the more their risk taking behaviors decrease over the high school years. Although our data do not speak to the direct mechanisms by which this reward sensitivity is protective, it is possible that adolescents who attain more reward from prosocial behaviors find risk taking contexts to be comparatively less rewarding. Future studies should examine whether heightened reward activation in the context of positive behaviors (e.g., prosocial behaviors) relates to decreased reward activation in the context of negative behaviors (e.g., risk taking). If this is the case, it would suggest that redirecting adolescents' emotions towards meaningful activities, such as providing assistance to one's family, could greatly reduce susceptibility to risky behavior.

Our findings are consistent with other developmental neuroimaging research that shows that heightened ventral striatum activation can be adaptive. For example, in a longitudinal study examining changes in neural responses to emotional facial expressions, Pfeifer and colleagues

(2011) found that increases in VS activation were associated with decreases in risky behavior, suggesting that the VS may also be involved in emotion regulation during adolescence. Thus, depending on the context, heightened VS activation may be both a vulnerability as well as a protective factor. Perhaps only when involved in risky behaviors (e.g., Chein et al., 2011) or personal rewards (e.g., Galvan et al., 2007) is VS activation maladaptive. In contrast, when directed towards positive, prosocial rewards (e.g., current study) or opportunities to engage in emotion regulation (e.g., Pfeifer et al., 2011), heightened VS activation is adaptive.

Interestingly, VS activation to prosocial behaviors did not predict risk taking behavior at Time 1 even though Time 1 and Time 2 risky behavior were highly correlated. Rather, VS activation predicted *changes* in risk taking behavior over the course of a year. Thus, adolescents' risk taking changed in meaningful, predictable ways: adolescents who showed greater activation in the VS when contributing to their family showed declines in risk taking behavior over time, whereas adolescents who showed greater activation in the VS to personal rewards showed increases in risk taking behavior over time. The ability to prospectively predict future engagement in risk-taking behaviors based on adolescents' current neural sensitivity to rewarding behaviors can have profound effects on our ability to develop and implement individualized prevention programs, which have been shown to produce greater behavior change than general, one-size-fits-all programs (McLeod & Shantz, 2002). Our results suggest that findings ways for adolescents to direct their new motivations and passionate emotions towards positive behaviors can have lasting implications for their health. Thus, parents, teachers, and practitioners should help adolescents channel their emotions into positive behaviors, such as prosocial behaviors. In addition, future research should examine how other meaningful activities in adolescents' lives, such as participating in community service, engaging in positive peer relationships such as academic clubs, and religious engagement can similarly reduce risk taking among diverse adolescents. Identifying the behaviors that are the most meaningful and rewarding for each individual adolescent will have the greatest impact on their health.

This study is significant in light of a growing trend in neuroimaging research to move beyond brain mapping and statistical association to actual prediction of behavior (Falk et al., 2010). Traditional neuroimaging research has typically used behavioral outcomes as regressors to predict responses in different brain regions. New advances in neuroimaging have begun to use neural activation to predict behavior either concurrently (Haxby et al., 2001) or in the future (Soon et al., 2008; Falk et al., 2010; Falk et al., 2011). We build upon this research and show that neural activation can predict behavior change over the course of a year and may be even more accurate than self-reported intentions to engage in that behavior. By measuring VS activity in the moment as participants engaged in prosocial behaviors to their family, we were able to predict changes in participants' risk taking behaviors above and beyond their own self-reported intentions to engage in such behavior.

In conclusion, adolescents are inclined towards novelty and excitement, and passions are ignited (Dahl, 2004). Indeed, much research has documented how this these new and intense emotions can create vulnerabilities for adolescents, leading to maladaptive behaviors. In contrast, little research has examined how these passions can create opportunities for adolescents to channel their emotions into positive goals and behaviors. Our findings are among the first to suggest that heightened reward sensitivity can be positive for adolescents, reducing risk taking behaviors over time. If adolescents direct their emotions and motivations towards positive, goal-directed behaviors, such as prosocial activities, reward sensitivity can be an asset.

Figure 4.1. The Family Assistance Task includes several trial types including Noncostly Rewards, Costly Donations, and Controls. Each trial was interleaved with a fixation.

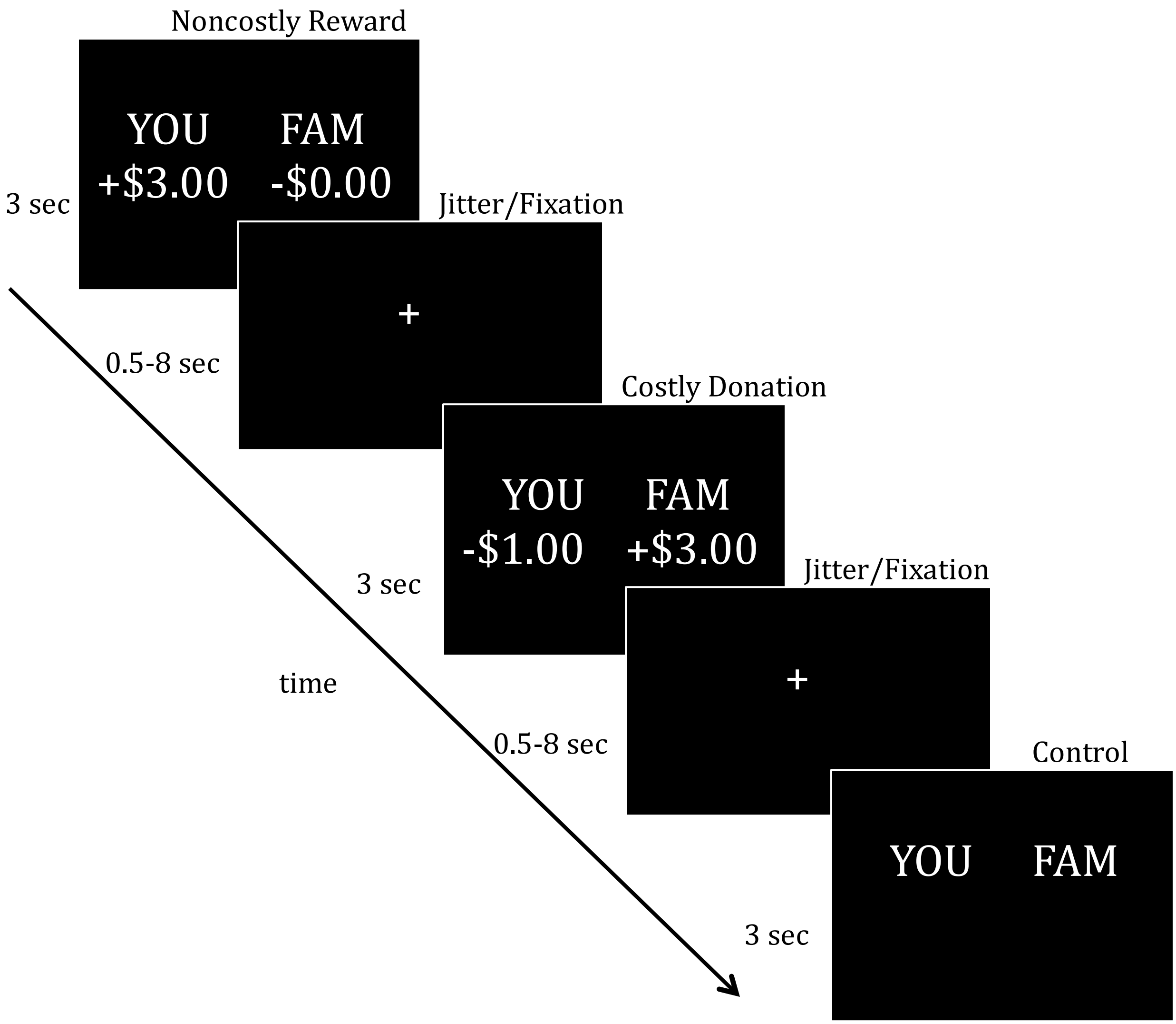
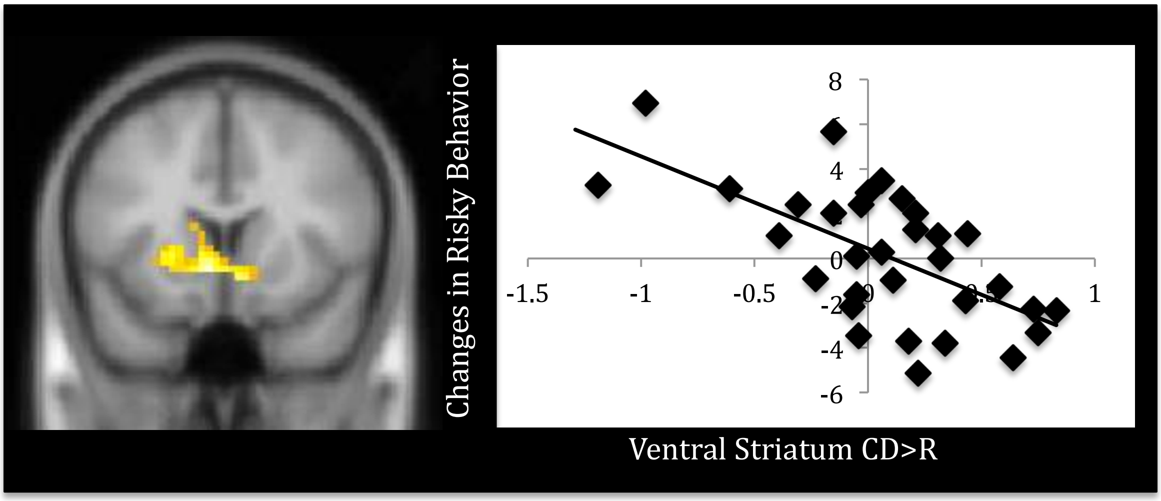


Figure 4.2. Ventral striatum activation when making financial sacrifices to the family is associated with longitudinal declines in risk taking behavior.



Note. x y z = -6 14 -5, $t(31)=3.71$, $p<.005$, corrected, 109 contiguous voxels. For the scatterplot, parameter estimates of signal intensity were extracted for each individual from the entire, group-level cluster of activation.

Table 4.1. Neural Regions Activated during Costly Donation and Noncostly Reward Trials

Contrast	Anatomical Region	x	y	z	*t*	*k*
CD>Control						
	R VS	9	14	1	4.15	181[a]
	R DS	9	14	7	5.49	181[a]
	L VS	-12	20	-2	4.16	75
	dACC	6	38	25	6.38	223
	R anterior insula	36	20	-2	6.54	35
	L anterior insula	-30	20	-2	6.37	68
	Ventral midbrain	3	-19	-14	4.27	214
	Cuneus	-3	-85	-5	12.72	2814
	L precentral gyrus	-42	5	31	4.29	82
NCR>Control						
	R VS	15	20	1	4.75	170[b]
	R DS	3	11	10	5.90	170[b]
	L VS	-12	17	1	3.32	99
	dACC	6	41	19	6.61	179
	Cuneus	-6	-85	-5	15.71	3220
CD>NCR						
	dACC	12	26	28	5.02	204
	Ventral midbrain	6	-16	-8	4.16	101
	L anterior insula	-30	17	7	4.14	173
	Cuneus	24	-73	-5	6.45	610
NCR>CD						
	R inferior insula	39	-4	-2	4.38	173
	L inferior insula	-39	-7	-2	3.77	90
	L Fusiform gyrus	-30	-40	-11	3.54	52

Note. CD>Control refers to the contrast comparing Costly Donations trials to the Control trials. NCR>Control refers to the contrast comparing Noncostly Reward trials to the Control trials. L and R refer to left and right hemispheres; x, y, and z refer to MNI coordinates; *t* refers to the t-score at those coordinates (local maxima); *k* refers to the number of voxels in each significant cluster. Anatomical regions that share functional clusters are denoted with the same superscript letter. All regions are listed at cluster-forming threshold of $p<.05$ corrected for multiple comparison. The following abbreviations were used for the specific brain regions: VS=ventral striatum; DS=dorsal striatum; dACC=dorsal anterior cingulate cortex.

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Chapter 5

Conclusions, Significance, and Future Directions

Challenges associated with immigration place adolescents from Mexican backgrounds at risk for a variety of adjustment problems, including higher rates of alcohol, cigarette, and drug use (CDC, 2005). In order to address these health disparities, there is great need for systematic research that examines the nature of family relationships among adolescents from Mexican backgrounds. Familism is a fundamental aspect of family life, which implies children's role in the support and assistance of their family. Familism has important implications for the adjustment of adolescents from Mexican backgrounds. For example, familism is associated with lower rates of drug use and externalizing behaviors among Mexican youth (e.g., German et al., 2009). Efforts to facilitate the adjustment of adolescents from Mexican families need to incorporate an understanding of the significance of familism in the lives of these youth. Identifying the mechanisms by which familism protects youth from engaging in risk taking behaviors can help researchers develop effective interventions for reducing externalizing behaviors and substance use among this at-risk population. Moreover, an understanding of the underlying mechanisms of familism will help researchers to understand how other types of relationships and behaviors may be protective for adolescents from diverse cultural backgrounds.

In this dissertation, I implemented a multi-method, longitudinal program of research, including daily diaries, experimental tasks, and functional magnetic resonance imaging (fMRI), to examine the mechanisms by which familism buffers Mexican youth from drug use and risk taking. This multi-method approach allowed me to examine important links between behavioral and neural processes and revealed that familism is a unique aspect of family relationships. Results suggest that familism is protective because it helps youth to make better decisions such as avoid deviant peers (Chapter 2), it is associated with decreases in reward sensitivity and increases in cognitive control, thereby potentially reducing a neural imbalance associated with risk taking (Chapter 3), and it is a particularly meaningful and rewarding type of family relationship (Chapter 4).

Significance and Contributions

Dual Systems Models of Adolescent Neurodevelopment. Dual systems models of adolescent development suggest that adolescents are predisposed towards risk taking due to an imbalance between the early maturation of limbic motivational and emotional systems, and a slower or later maturation of prefrontal cortical control (Casey et al., 2011; Steinberg, 2008). The dual systems model has offered promising ways to understand the development of risk taking during adolescence, but we know little about how social processes interact with these neural processes to impact risk taking. Results of this dissertation provide evidence of the complexity of adolescent brain-behavior relationships and provide new ways to understand neural processes underlying adolescent risk taking.

Not all adolescents engage in maladaptive, health compromising risky behavior. Although risk taking may represent a normative developmental experience, there are significant individual differences in the severity of this risk taking. Some adolescents actively seek out thrilling experiences and engage in deviant behaviors whereas other adolescents avoid behaviors that can have negative consequences. Some adolescents experiment with and become addicted to drugs, whereas other adolescents choose to avoid substance use. A normative, one-size fits all neural imbalance during adolescence cannot explain these individual differences in adolescent risk taking. Study 1 of my dissertation shows that higher family obligation values relate to lower levels of substance use behaviors, and Study 2 shows that these family obligation values may reduce the neural imbalance between limbic and regulatory regions present during adolescence. Those with the highest family obligation values showed the lowest reward sensitivity and the greatest prefrontal cortical control. Therefore, the extent of the neural imbalance present during adolescence may vary across individuals depending upon their social relationships. Future research should continue to examine individual differences in neural sensitivity to risk taking and cognitive control to identify ways in which the developmental curves of subcortical and cortical brain regions may vary as a function of individual experience.

The dual systems model of adolescent development highlights how the early maturation of the ventral affective system, namely the ventral striatum, predisposes adolescents to reward-seeking behavior. Interestingly, this heightened reward sensitivity has largely been suggested to lead to increased risk taking behaviors (Casey et al., 2011; Steinberg, 2008). Results of Study 3 show that activation in the ventral striatum to prosocial behaviors to the family is associated with declines in risk taking over time. To my knowledge, this is the first study to document that neural reward sensitivity can be an asset for youth. Therefore, the very same processes (i.e., reward sensitivity) that confer risk for adolescent risk taking according to the dual systems model can also be protective against this same behavior. Thus, adolescent risk taking is a complex behavior that interacts with many social factors, and this complexity should be incorporated into models of adolescent brain development.

Together, the results of these studies suggest that the functional maturation of brain regions involved in reward and cognitive control can be altered by social experiences. By engaging in meaningful family relationships that provide adolescents the opportunity to practice self-control and place their family's values and needs before their own, adolescents may show maturation in functional brain development. However, given that these data do not examine brain function across time, it is also possible that adolescents whose brains differ in meaningful ways have developed stronger family obligation values as a function of that brain maturity. Therefore, it is important for future work to examine how the brain changes across development, how changes in brain development lead to changes in behavior, and how early social experiences alter trajectories of brain development.

Implications for Reducing Adolescent Risk Taking. Results of my work have significant implications for reducing risk taking among adolescents. My findings indicate that familism is a unique aspect of family relationships that reduces risk taking above and beyond the effects of more general family cohesion. In fact, family cohesion and support were not related to neural activation during risk taking or cognitive control even though family cohesion has been associated with lower rates of externalizing behaviors and drug use. Therefore, family obligation is a unique type of family relationship, suggesting that it is not simply about having a close and supportive family that reduces neural sensitivity to risk. Rather, family relationships that foster self-regulatory skills and an avoidance of behaviors that could have negative consequences may be particularly protective against adolescent risk taking. These findings suggest that interventions designed to increase family cohesion and support may not have lasting effects on adolescent risk taking. Instead, interventions should be designed to target relationships that allow adolescents to practice self control, to put the needs of others before their own, and to increase the perception that their behaviors can impact others in negative ways.

Secondly, familism is a meaningful and rewarding activity for adolescents, and the extent of this reward is associated with reduced risk taking over the high school years. Adolescents who showed greater ventral striatum activation when providing assistance to their family showed longitudinal declines in risk taking. The meaningful nature of family assistance is perhaps the most distinctive aspect of this type of family relationship. Indeed, in my prior work, I have found that adolescents who help their family feel that they are fulfilling important roles within their family and this relates to higher levels of happiness (Telzer & Fuligni, 2009a). Thus, the meaning attained from this activity appears to be particularly protective. These findings suggest that interventions should take advantage of adolescents' increased reward sensitivity by directing them towards meaningful activities. If adolescents engage in behaviors that are personally meaningful and rewarding, they may be less inclined to engage in risk taking.

Future Directions

Peer versus Parental Influence on Adolescent Risk Taking. During adolescence, youth must negotiate their family and peers, with peers often becoming more salient and influential. In fact, vulnerability to peer pressure peaks in mid-adolescence and risk taking substantially increases in the presence of peers, often by more than 50% (Gardner & Steinberg, 2005). Thus, I hope to extend this program of research by simultaneously examining how the family and peers influence risky decision making across diverse youth. Because youth from different cultures place different emphasis on family and peers, these agents may differentially affect their engagement in drug use and risk taking behaviors. Perhaps peers are less influential among individuals who place greater value on family solidarity. In addition, there is a large body of work examining the role of negative peer influence on adolescents' risky behavior, and work by Steinberg and colleagues (Gardner & Steinberg, 2005; Chein et al., 2011) has shown that behavioral and neural sensitivity to risk taking increases in the presence of peers. I hope to conduct research to examine the influence of positive peers on adolescent risk taking. Peer relationships that are particularly meaningful and rewarding will likely function in the same way as family assistance. Just as the family can be protective by increasing cognitive control and reducing reward sensitivity, I predict that positive, achievement oriented friends, could function in this same way.

The Rewards versus Burdens of Family Assistance. Although family assistance is a rewarding and meaningful aspect of family relationships, it is not always a protective factor. As evidenced in Study 1, family assistance within high conflict homes is related to heightened substance use. Moreover, in my previous work, I have found that family assistance is experienced as demanding (Telzer & Fuligni, 2009a), relates to declines in the academic performance of Mexican American youth (Telzer & Fuligni, 2009b), and puts a toll on adolescents' physical health (Fuligni, Telzer, et al., 2009). Thus, Family assistance may be stressful for some adolescents due to the burden of taking on extensive household tasks in the face of competing demands such as socializing with friends and studying for school. The stress associated with family assistance can be significant because adolescence is a developmental period during which individuals may be particularly reactive to stress, as indexed using cortisol assays. Both animal models and recent work in humans have demonstrated a heightened and prolonged stress hormone response to environmental demands in adolescents, as compared to older and younger groups (Romeo & McEwen, 2006; Gunnar, et al., 2009; Romeo et al., 2007).

Using daily diaries in conjunction with diurnal cortisol, I hope to gain a better understanding of when and for whom is family assistance experienced as stressful. Using daily diary methodology to examine the daily link between family assistance and biological markers of stress allows for estimates of individual differences in reactivity to experiences within a person across time. For example, I hope to examine whether some individuals show a greater spike in anxiety or heightened cortisol reactivity on days in which family conflict and high levels of family assistance are experienced. Moreover, I hope to examine how stress reactivity to family assistance, as measured by cortisol reactivity, relates to neural activity during risk taking and cognitive control. This knowledge will help us to gain a better understanding of the risk and protective nature of family assistance. Clearly family assistance is a meaningful and rewarding activity for adolescents, but it can also be stressful. Gaining a deeper understanding of when and why family assistance is stressful will aid in the development of interventions aimed at increasing cultural values and behaviors.

Conclusions

Families from Latin American backgrounds represent the largest ethnic minority group in the United States, and adolescents within these families face substantial challenges to their behavioral adjustment. Results of this dissertation indicate that traditional family values and practices play a critical role in shaping Mexican adolescents' risk for substance use and risk taking behaviors. I examined an aspect of family life that is culturally relevant to Mexican families. By taking this approach, I was able to identify a "cultural resource." Importantly, family obligation and assistance are fundamental aspects of family life among adolescents from Mexican backgrounds, are meaningful and rewarding behaviors, and thus have important implications for risk taking and substance use. Mexican adolescents' decisions to engage in risk taking appear to depend, in part, upon their cultural values and behaviors.

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