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Age and Social Context Modulate the Effect of Anxiety on Risk-taking in Pediatric Samples

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Abstract

Although risk-taking has been studied from a developmental perspective, no study has examined how anxiety, age, risk-valence and social context interact to modulate decision-making in youths. This study probes this question using a risk-taking task, the Stunt Task, in clinically anxious children ($n=17$, 10 F, age=8.3–12.1 years), healthy children ($n=13$, 4 F, age=9.3–12.2 years), clinically anxious adolescents ($n=18$, 6 F, age=12.3–17.7 years), and healthy adolescents ($n=14$, 10 F, age=12.5–17.3 years). Social context was manipulated: in one condition, participants were led to believe that a group of peers were observing and judging their performance (peer-judge), while, in the other condition, they were led to believe that peers were not observing them (control). Only anxious children showed an influence of social context on their risk-taking behavior. Specifically, anxious children bet significantly less and had slower reaction times (RT) during the peer-judge than control condition. However, across social conditions, risk-valence modulated RT differently in function of age and diagnosis. Anxious children were slower on the positive-valence risky trial, whereas anxious adolescents were slower on the negative-valence risky trials relative to their respective healthy peers. In conclusion, clinically anxious children were the only group that was sensitive (risk-averse) to the effect of a negative peer-judge context. The negative peer-judge context did not affect risky decision-making in adolescents, whether they were anxious or healthy. Future work using a stronger aversive social context might be more effective at influencing risky behavior in this age group.

Keywords

Peerjudgement; Adolescents; Children; Clinical anxiety

People engage in risky decisions every day, but the pattern of risk-taking varies greatly from one person to another. Some of the factors that account for such individual variability include anxiety (Aupperle and Paulus 2010; Giorgetta et al. 2012), age (Ernst 2014;

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Steinberg 2008) and social context (e.g., Gardner and Steinberg 2005; Pfeifer et al. 2011). These three factors, anxiety, age and social context, are examined in the present work.

Empirical findings link risk-avoidance to anxiety (Butler and Mathews 1987; Chorpita and Barlow 1998; Lorian and Grisham 2010; Maner et al. 2007; Maner and Schmidt 2006). Anxiety is associated with exaggerated interpretation of stimuli or events as potentially dangerous, and concomitant increased attention to potential threats in the environment (Mathews and Mackintosh 1998). As a result, anxiety promotes behavioral avoidance of threatening stimuli (Lorian and Grisham 2010; Mineka and Oehlberg 2008) and negative appraisals of future events (Shepperd et al. 2005). Accordingly, a higher uncertainty of outcome (risk-level) and a higher likelihood of negative outcomes (i.e., negative risk-valence) would be expected to increase risk avoidance, an effect that would be amplified in anxiety. However, a subset of individuals may make risky choices as a way to provide relief from their negative affect (Cooper et al. 2000). For example, non-clinically socially anxious individuals have been shown to engage in risky sex and alcohol and drug abuse behaviors (Kashdan et al. 2008), and, similarly, individuals with social anxiety disorder have been found to be elevated on novelty-seeking behaviors (Kashdan and Hofmann 2008). Anxiety is the first factor we examine as a modulator of risk-taking in youths.

Strong evidence, from both behavioral and neural studies, demonstrate changes in the level of risk-taking across development (Cauffman et al. 2010). These changes are proposed to serve an evolutionary adaptive goal by facilitating a shift (during adolescence) towards independence and, in turn, promoting reproduction (Spear 2000). Indeed, an essential function of adolescence is to transition away from the protective family nest, engage with peers, and form romantic relationships to ensure reproductive success (Ellis et al. 2012). A number of studies have documented that adolescence is a developmental period when risky behaviors (e.g., dangerous driving, drug experimentation, unprotected sex) reach a peak (e.g., Steinberg 2007). Researchers propose that this surge in risky behavior may be supported by a normative pattern of brain development occurring in adolescence. This pattern has been described using neural systems models based on two and three functional neural systems, known as the dual and triadic systems models, respectively. With regard to the dual systems model (Casey et al. 2008; Romer 2010; Steinberg 2008), two neural systems underlying cognitive control and reward processes are considered. The premises of this model ascribe a relative inefficiency of cognitive control vs. a relative hypersensitivity of reward processes, yielding a state of poorly regulated reward-guided behaviors. Age-related changes in cognitive and behavioral control, specifically the inhibition of impulsive responses, gradually increase from childhood to adolescence. This pattern has been recognized at the neural level, where cognitive control areas of the brain are recruited less strongly in children (8–13 year olds) than in adolescents (14–17 year olds) (Luna et al. 2001). In contrast, activity of the reward-related system is higher in adolescents (13–17 year olds) compared to children (7–11 year olds) (Galvan et al. 2006), leading to a neural systems balance that biases goal-directed behaviors towards risk-taking. With regard to the triadic neural systems model (Ernst 2014; Ernst et al. 2006), this balance is triangulated across cognitive control, reward-related (approach) and threat-related (avoidance) functional neural systems. The triadic model assumes that biological (e.g., age, genetics) and environmental factors (e.g., threat context, social conditions) determine the equilibrium reached across

these three functional systems. As such, the triadic framework can render not only the adolescent peak in risk-taking behavior, but also general patterns of motivated behaviors in health and disease, and across development. Of note, most studies of risk-taking have focused on the adolescent period and its transition into adulthood (see reviews, Defoe et al. 2014; Richards et al. 2013), leaving the transition from childhood to adolescence relatively uncharted. The present work addresses the influence of age on risk-taking, specifically the transition from childhood into adolescence.

Finally, the transition to adolescence is marked by a transformation of the adolescent social context. Adolescents display a change in their social anchors, becoming peer- rather than family-centered. They also exhibit intense sensitivity to peer criticisms, while, at the same time, acutely seeking peer approval (e.g., Gardner and Steinberg 2005; Pfeifer et al. 2011; Smith et al. 2013). These social changes result in a stronger and more powerful influence of peers on adolescent decision-making. The few laboratory studies focusing on peer influence on risk-taking suggest that exposure to peers, in a positive (supportive, friendly peers) or neutral (neutral, unfamiliar peer) context, increases risk-taking or sensitivity to reward. For example, a positive social context, such as being observed by supportive friends, has been shown to increase risky decision-making in adolescents, but less so in adults (Chein et al. 2011; Gardner and Steinberg 2005; Steinberg 2005). A similar effect was reported in a more neutral social condition, consisting of being observed by a single, unfamiliar neutral peer (Weigard et al. 2014). Less is known on the influence of a negative social peer context, such as critical or hostile unfamiliar peers, on risk-taking. In this regard, Somerville and colleagues (2013) implemented a social context consisting of participants being observed up close by an unfamiliar peer through a video-feed camera, placed right above their face while lying in an MRI scanner. This social context was slightly aversive, as it elicited a certain degree of embarrassment and autonomic arousal (skin conductance response). It was most aversive for adolescents (~15 years) compared to the younger or older subjects of the sample (8–23 years) (Somerville et al. 2013). While not examining risk-taking behavior, this study, along with the Weigard et al. (2014) study, concur on the notion that adolescents are uniquely sensitive to being observed by an unfamiliar peer. However, it remains unclear whether a negative social context, eliciting negative emotions like embarrassment (Somerville et al. 2013), would also enhance risk-taking as demonstrated in response to a positive or relatively neutral social context (e.g., Chein et al. 2011; Weigard et al. 2014).

The focus of this study is primarily to understand the pattern of risky decision-making in anxious youths. To this goal, we examine the influence of three factors, (1) anxiety, (2) age, and (3) social context on risky decision-making. Given the focus on anxiety, we will consider specifically the effects involving anxiety (i.e., main effect of anxiety), the moderation of these effects by social context (i.e., anxiety by social context interactions), and the influence of age on these interactions (i.e., anxiety by social context interactions by age). The effects of anxiety are addressed by studying a sample including both clinically anxious and healthy youths. The effects of age are studied by comparing children and adolescents. Finally, the effects of social context are assessed by implementing two conditions, a non-social control condition and a mildly aversive social condition that consists of being judged by a group of unfamiliar peers.

Based on prior work, our hypotheses are three-fold:

1. Regarding the effects of anxiety, we hypothesize that, based on anxious individuals' hypersensitivity to the uncertainty of future events (Craske et al. 2009), clinically anxious youths vs. healthy youths will be more risk-averse. Similarly, based on the hypersensitivity of anxious individuals to the likelihood of negative outcome, we hypothesize that anxious youths will be particularly risk-averse to trials with higher uncertainty levels and trials with more negative probabilistic outcomes. Given the paucity of studies in youths on this topic, the prediction that anxious youths will be more risk-averse is based on previous work in adults (Butler and Mathews 1987; Chorpita and Barlow 1998; Lorian and Grisham 2010; Maner et al. 2007; Maner and Schmidt 2006).
2. Regarding the interaction of anxiety and social context, we hypothesize that clinically anxious youths vs. healthy youths will be more sensitive to the social context, as anxious youths often display exaggerated concerns of criticisms by others and of being negatively evaluated (Ginsburg et al. 1998; Kendall 2012; Teachman and Allen 2007; Weems et al. 2000). We expect that the social context will potentiate risk averseness in the anxious group. The direction of the social context's effect on risk-taking in the healthy group is not clear since there are no precedents in the literature on the effects of a mildly aversive social context on risk-taking in youths.
3. Finally, regarding the effects of anxiety on the interaction of age and social context on risk-taking, we hypothesize that anxious adolescents will be less risk averse and more sensitive to the social context than anxious children given the peak in risk-taking (Steinberg 2007) and sensitivity to social peers in adolescence (Gardner and Steinberg 2005; Pfeifer et al. 2011; Smith et al. 2013). We also expect healthy adolescents to be greater risk-takers and more sensitive to the peer social context than healthy children. This last set of interactions is difficult to predict more clearly given that the direction of the effects of a negative peer social context on risk-taking in youths has not been empirically examined. These findings will bring new data on the relatively untouched, but critical, question of the modulation of risk-taking by clinical anxiety and social context across childhood and adolescence.

Method

Participants

Participants were 62 clinically anxious and healthy children and adolescents of both genders (27 healthy and 35 with an anxiety disorder). Four additional participants, two healthy and two patient participants, were excluded from analysis because of unreliable performance (see below). The sample was divided into children (8.33 to 12.17 years old) and adolescents (12.25 to 17.67 years old), based on a median split of the age distribution. The final sample included 27 healthy youths ($M_{age}=12.83$ years, $SD=2.33$ years; 14 adolescents and 13

children) and 35 clinically anxious patients ($M_{age}=12.09$ years, $SD=2.52$ years; 18 adolescents and 17 children) (see Table 1 for sample characteristics).

Participants were recruited through local newspaper and magazine advertisements and word of mouth. Participants and their parent(s) were interviewed separately to determine diagnostic status using the Kiddie-Schedule for Affective Disorders and Schizophrenia (K-SADS; Kaufman et al. 1997). Interviews were conducted by trained clinicians who demonstrated excellent inter-rater reliability ($\kappa>0.75$). Clinicians were trained through a series of classes and interviews performed by a senior clinician. Inter-rater reliability was determined through the following steps. First, the trained clinician and another senior clinician independently rated a series of 20 taped clinical interviews, which were evaluated to determine that the trained clinician exceeded the minimal threshold for reliability ($\kappa>0.70$). Following this, each interview performed by the clinician was taped and 10 % of the interviews were randomly selected to be reviewed by another senior clinician. Finally, each participant in this study was independently rated and diagnosed by two clinicians during two visits, separated by at least a week. Potential reasons for diagnostic discrepancies were discussed by the group of senior and trained clinicians, and a consensus was reached. All healthy participants were free of acute or chronic medical problems and current or past psychiatric disorders. Clinically anxious youths met criteria for a primary diagnosis of an anxiety disorder. Two anxious youths had comorbid attention deficit hyperactivity disorder (ADHD) and two had comorbid oppositional defiant disorder (ODD). Anxiety symptom severity was assessed using the Screen for Child Anxiety Related Emotional Disorders (SCARED; Birmaher et al. 1997) and the average score was computed from the child- and parent-SCARED scores (SCAREDpc; see supplementary material Table S1). Depression symptom severity was assessed using the Children's Depression Inventory (CDI; Kovacs 1985) (see supplementary material Table S1 for results).

Exclusion criteria for all participants included use of psychoactive medications, current and lifetime history of Tourette's syndrome, obsessive-compulsive disorder, PTSD, conduct disorder, exposure to extreme trauma, suicidal ideation, mania, psychosis, or pervasive developmental disorder. All participants had an intelligence quotient above 80 (Wechsler 1999) (see Table 1).

The study was approved by the National Institute of Mental Health Institutional Review Board. Parents of child and adolescent participants provided informed consent, and children and adolescents gave informed assent. Participants were financially compensated.

Procedure

Stunt Task—We used the recently developed Stunt Task (Patel et al. 2015), which is child-friendly and provides a large range of risk-taking levels (Fig. 1). Before beginning the task, participants were read instructions by a research assistant and were asked questions to ensure comprehension of the task. Participants then completed a practice version of the task on the computer. During the task, participants viewed a motorcyclist who was challenged to jump over a variable number of buses (one through nine). They were asked to bet or pass by button press, indicating whether they believed the motorcyclist could make the jump over the buses or not. The number of buses (risk-level) corresponded to nine probabilities of

successful jumps, ranging from 90 to 10 %. Each risk-level included 10 trials, and trial types were randomized across the task. Every trial began with the presentation of the motorcyclist about to jump a certain number of buses (3000 ms). Through button press, participants chose to bet if they believed the motorcyclist would make the jump over the buses and pass if they believed the motorcyclist would not make the jump. Next, the motorcyclist was shown jumping (1000 ms), followed by an image of the outcome of the jump, i.e., success or failure of the jump (1000 ms). A fixation-cross separated the trials (jitter applied across 750–1150 ms). Successful bets were rewarded two points and unsuccessful bets were punished with the loss of two points. A pass response resulted in no exchange of points. To discourage missing trials, two points were deducted for each trial in which no response was made (missed trial). Participants were told that points would be converted into a dollar amount according to a set algorithm and that they would receive this amount at the completion of the study.

At the end of the study, participants completed self-report questionnaires. In one, participants rated on a 1–10 Likert scale (1=*very negative*; 5.5=*not positive or negative*; 10=*very positive*) how they felt about each of the risk-levels (see Supplementary Figure S1a). Participants also selected the two trial types that were the most difficult on which to make a decision (see Supplementary Figure S1b). Lastly, they were asked questions about the social context condition: 1) How competitive do you think the kids are? 2) How critical do you think the kids are? 3) How critical do you think the kids are of your performance? (see Supplementary Figure S1c).

Social-condition—Participants completed the task twice, once while being judged by a group of five, same-sex, age-matched peers through a video-camera feed and once without being observed (control). The order of the conditions was counterbalanced across participants. A tripod and video-camera were arranged in the testing room, and the camera was ostensibly turned on for the peer-judge condition and off for the control condition. To make the peer-judge condition realistic, a special script was developed. Specifically, at the beginning of the peer-judge condition, the research assistant running the task made a phone call to establish the live-feed and received a phone call back to indicate that the peers were ready to begin. Additionally, participants were told that a group of peers would rate them on their performance.

Data Analysis

Missing trials and outliers of 2.5 standard deviations above and below the mean for individual reaction times (RTs; invalid) were removed from the analysis. We excluded subjects who missed more than 10 trials or who did not vary their responses for more than 20 consecutive trials. Three subjects were excluded for no modulation of choice and one for missing trials.

Group differences for IQ, SES and age were analyzed using a two-way analysis of variance (ANOVA) with the between-group factors of Age-Group (children, adolescents) and Diagnosis (anxious, healthy). Group differences for sex were analyzed using chi-square tests. Task performance measures included betting-rate, the percentage of bets made over the number of completed trials, and RT to select an option. Betting-rate was analyzed using a

repeated measures analysis of variance (rANOVA) with Social-Condition (peer-judge, control) and Risk-Level (buses one through nine) as the within-subjects factors, and Diagnosis and Age-Group as the between-subjects factors. RT was analyzed via a linear mixed model analysis with Decision (bet, pass), Social-Condition, and Risk-Level as the within-subjects factors, and Diagnosis and Age-Group as the between-subjects factors. Alpha was set at 0.05. Greenhouse-Geisser corrections were made for violations of sphericity for rANOVA. Bonferroni corrections were used to adjust for multiple t-tests. We examined the potential effects of sex and IQ on betting-rate and RT in the whole sample and by Diagnosis and Age-Group. Since there were no significant effects, these variables were not included in the final analyses.

Results

Demographics

A two-way ANOVA with between group factors of Age-Group and Diagnosis revealed no significant interactions of Age-Group by Diagnosis for IQ, SES, or age. There were main effects of Age-Group on IQ, $F(1,52)=6.09$, $p<0.05$, indicating that children had a higher mean IQ ($M=113.73$, $SD=14.59$) than adolescents ($M=105.67$, $SD=12.55$) and Diagnosis on IQ, $F(1,52)=4.17$, $p<0.05$, indicating that healthy youth had a higher mean IQ ($M=114.28$, $SD=12.98$) than anxious youth ($M=106.43$, $SD=14.12$). Chi-square tests revealed that there were more females in the healthy than anxious adolescent group, $\chi^2(1)=4.57$, $p<0.05$, and the healthy adolescent than healthy child group, $\chi^2(1)=4.46$, $p<0.05$. There were no significant differences in sex distribution when comparing anxious children vs. healthy children, or anxious children vs. anxious adolescents.

Social Context Manipulation

The social manipulation was evaluated via participants' subjective ratings about the peers who were observing them. Participants reported the peer-observers to be moderately critical, (competitive: $M=5.9$, $SEM=0.31$, critical: $M=4.5$, $SEM=0.28$, and critical of the participants' performance: $M=6.1$, $SEM=0.36$), suggesting that the deception and negative social manipulation were successful. In addition, an ANOVA showed no significant effects of Diagnosis, Age-Group, or Diagnosis by Age-Group on any of these variables, indicating that age and/or diagnosis did not influence the subjective ratings about the peer-judges, $ps>0.1$. These data indicate that the social manipulation was equally successful for adolescents and children, and anxious and healthy subjects.

Risk-Level Manipulation

After having completed the task, participants rated how they felt about the different Risk-Level trials on a scale of 1 (*negative*) to 10 (*positive*). As expected, these responses indicated a linear relationship with win-probability level (i.e., a more positive feeling with a greater likelihood to win; see supplementary material, Fig. 2S), and all risk-levels significantly differed from the midpoint of the scale, 5.5, $ps<0.01$, except for risk level 5, $p>0.1$. Bonferroni corrections were applied with a critical value of 0.006 for the nine conducted tests. Participants also reported the two trial-types that required the most difficult decision (Fig. 2). Buses four, five, and six were the most difficult trials to decide on, as expected.

Betting-Rate

A 4-way rANOVA of Social-Condition by Risk-Level by Diagnosis by Age-Group (see Table 2 for mean betting-rates) revealed a significant 3-way interaction of Social-Condition by Diagnosis by Age-Group, $F(1,58)=12.16$, $p<0.01$, $\eta^2=0.17$ (Fig. 3). This analysis was further decomposed by Age-Group, showing a significant interaction of Social-Condition by Diagnosis in children, $F(1,28)=9.34$, $p<0.01$, $\eta^2=0.25$, but not in adolescents. Anxious children bet significantly less in the peer-judge than the control condition, $p<0.01$. No such effect was seen in healthy children. Of note, adolescents' risky decision-making was not sensitive to the peer-judge condition.

The rANOVA also revealed a main effect of Risk-Level, $F(3.97, 229.96)=352.01$, $p<0.01$, $\eta^2=0.86$, which, as expected, reflected a lower betting-rate with lower win-probability. No other interactions or main effects were significant.

Reaction Time

The linear mixed model analysis of Social-Condition by Risk-Level by Decision by Diagnosis by Age-Group (see Table 3 for mean RTs) revealed a significant three-way interaction of Social-Condition by Diagnosis by Age-Group, $F(1, 1578.90)=9.67$, $p<0.01$, $d=0.16$ (Fig. 4). This analysis was further decomposed by Age-Group. Children showed a significant interaction of Social-Condition by Diagnosis, $F(1, 774.70)=7.41$, $p<0.01$, $d=0.20$, in which anxious children were slower in the peer-judge condition compared to the control condition, $p<0.01$. Adolescents showed no significant interaction of Social-Condition by Diagnosis. These findings are consistent with the betting-rate findings reported above, reflecting that social judgment exerted a stronger effect on risk-taking (greater conflict) in children with anxiety than in healthy children or adolescents.

Additionally, the omnibus linear mixed model analysis revealed a significant three-way interaction of Risk-Level by Diagnosis by Age-Group, $F(8, 1577.89)=2.47$, $p<0.05$, $d=0.08$ (Fig. 5). This three-way interaction was decomposed by Age-Group. Children showed a significant interaction of Risk-Level by Diagnosis, $F(8, 772.63)=2.45$, $p<0.05$, $d=0.11$. Specifically, anxious children were significantly slower than healthy children on the four-bus trials only (60 % chance of win), $p<0.05$. Within adolescents, there was also a significant interaction of Risk-Level by Diagnosis, $F(8, 805.68)=2.42$, $p<0.05$, $d=0.11$, indicating that anxious adolescents were significantly slower than healthy adolescents on buses five, six, and seven (50 %, 40 %, and 30 % chance of win, respectively), $ps<0.05$. Therefore, the most uncertain (i.e., risky) trial-types elicited the largest differences in RT between healthy and anxious adolescents.

Additionally, several main effects were found. Children were significantly slower than adolescents, $F(1, 60.18)=4.17$, $p<0.05$, $d=0.53$. A main effect of Risk-Level, $F(8, 1577.89)=16.54$, $p<0.01$, $d=0.21$ indicated slower RTs for buses four to seven, the more uncertain and risky buses. Lastly, a main effect of Decision, $F(1, 1579.54)=5.57$, $p<0.05$, $d=0.12$, showed slower RTs on passes than bets.

Discussion

This study examined the influence of clinical anxiety, age, and social context on risky decision-making. Specifically, while most empirical studies of age effects on risk-taking have compared adolescents to adults (e.g., see review, Richards et al. 2013), we focused here on children and adolescents. Social context was manipulated by implementing a peer-judge condition, during which unfamiliar peers were judging the performance of the participants, a condition expected to be mildly aversive.

Findings were three-fold. The first finding concerns the effect of the social condition. Across all risk levels, only anxious children exhibited a modulation of their risky decision-making by the social context. Specifically, anxious children became more risk averse (lower betting-rate and longer RT) under the peer-judge condition compared to the control condition. This was not the case for adolescents or healthy children. The peer-judge condition tapped sensitivity to peer evaluation, which is expected to be exacerbated in most anxiety disorders. However, the peer-judges were rated as being moderately critical by the anxious and healthy groups and by the child and adolescent groups, indicating that the experience of being judged by peers was similar among these groups. Taken together, the most parsimonious explanation is that this social manipulation was not strong enough to interact with performance in adolescents, but was sufficiently robust to modulate risk-taking in anxious children. A setting where participants performed a risk-taking task in the same room as the peer-judges might have been more powerful to influence risky decision-making compared to the knowledge of being observed by a group of peers through a video-camera feed. This could be the next step to extend the findings of the present work.

The second finding reveals differences in risk-taking among the groups and was specific to RT. RT was modulated by risk-level and risk-valence differently in function of age and anxiety. Risk-level is defined by the uncertainty of the trial outcome: the most uncertain were the five-bus trials (50 % chance of success), and the least uncertain were the one-bus and nine-bus trials (90 % and 10 % chance of success, respectively). Risk-valence is either positive, i.e., a higher chance to win than to lose (one-bus through four-bus trials), or negative, i.e., a higher chance to lose than to win (six-bus through nine-bus trials). Anxious children were slower than healthy children only for the positive valence, high uncertainty trial (four-bus trials), while anxious adolescents were slower than healthy adolescents for the negative valence, high uncertainty trials (five-bus, six-bus, seven-bus trials). Collectively, these results might reflect a shift in the experience of risk from childhood into adolescence. RT is a measure of difficulty or effort to perform a task. Anxious children, relative to healthy children, experienced the positive-valence risk as more difficult or effortful, whereas anxious adolescents experienced the negative-valence risk as more difficult. A developmental change of the relative cost-benefit of punishment vs. reward could underlie this shift. A more complex mechanism, that involves an interaction between uncertainty and valence, could also be entertained. Given the paucity of work in this area, this finding needs to be replicated before further interpretation.

The last main finding reveals a significant effect of age on performance efficiency. RT across social contexts, diagnosis groups, and risk-levels was significantly faster in adolescents than

in children, as could be expected based on the refinement of sensorimotor skills with age (Blakemore and Choudhury 2006).

Limitations and strengths of this work need to be considered. Similarly to the majority of studies in anxiety, many children had comorbid anxiety disorders, which might have introduced some variability. Unfortunately, the sample size was too small to examine the role of each diagnosis separately. However, the patient sample included highly anxious youths, formally diagnosed with an anxiety disorder, and actively seeking treatment. These patients were not medicated. In the future, it would be important to examine the unique contribution of specific anxiety disorders to our findings. For example, we would expect that those with social phobia would be more sensitive to the peer-judge manipulation. Regarding the task, we employed a task highly sensitive to uncertainty, as it permitted us to assess nine levels of probabilistic outcomes (i.e., risk). We previously used this task successfully in adults (Patel et al. 2015), and, here, demonstrated its usefulness with pediatric samples. Finally, information on the pubertal status of youths could have provided a more meaningful distinction between children and adolescents. However, research focusing on the effects of pubertal maturation on risk-taking is limited and lacks a clear, causal relationship (Smith et al. 2013). Future studies should examine how pubertal status and hormones modulate social context and anxiety's influence on risk-taking behaviors.

In conclusion, this study suggests that the interaction of anxiety with risky decisions, i.e., decisions with probabilistic outcomes, is influenced by social context differentially in children and adolescents. Children with clinical anxiety were more vulnerable to the influence of peer-judgment and became more risk-averse relative to healthy children. It is unclear whether a stronger negative social manipulation would have similar or opposite effects in adolescents. Regarding the effects of age on the influence of anxiety on risk-taking, anxious adolescents experienced unique difficulties (longer RT) in responding to risky choices with greater probability for a negative outcome relative to healthy adolescents, whereas anxious children had more difficulties (longer RT) in response to a risky choice with greater probability for a positive outcome relative to healthy children. This study suggests that clinical anxiety and developmental changes from childhood into adolescence influence risk-taking in an experimental setting using a social manipulation involving peer judgment.

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Fig. 1.
Diagram of the Stunt Task

Fig. 2. Self-report ratings as a function of risk-level. Subjects selected the two trial-types that were the most difficult to decide on

Fig 3. Effects of Social-Condition, Diagnosis, and Age-Group on betting-rate. There was a significant three-way interaction of Social-Condition by Diagnosis by Age-Group. The interaction showed that anxious children bet significantly less in the peer-judge than control condition. * $p < 0.01$, error bars represent $\pm$ SEM

Fig. 4.

Effects of Social-Condition, Diagnosis and Age-Group on reaction time. There was a significant three-way interaction of Social-condition by Diagnosis by Age-Group. Reaction time was slower in anxious children in the peer-judge compared to control condition. * $p < 0.01$, error bars represent $\pm$ SEM

Fig. 5.

Effects of Risk-Level, Diagnosis and Age-Group on reaction time. Children showed a significant interaction of Risk-Level by Diagnosis. In children, anxious patients were slower than healthy subjects for the four-bus trials only. In adolescents, there was also a significant interaction of Risk-Level by Diagnosis, in which anxious adolescents were significantly slower than healthy adolescents for buses five, six, and seven. * $p < 0.05$, error bars represent $\pm$ SEM

Table 1

Sample characteristics

	Children (<i>n</i>=30)		Adolescents (<i>n</i>=32)	
	Anxious	Healthy	Anxious	Healthy
Demographics				
<i>n</i> (# female)	17 (10 F)	13 (4 F)	18 (6 F)	14 (10 F)
Age in years (SEM)	10.04 (0.26)	10.88 (0.27)	14.03 (0.44)	14.64 (0.43)
Age range in years	8.33–12.08	9.33–12.17	12.25–17.67	12.50–17.33
IQ (SEM)	109.65 (3.51)	119.08 (3.73)	103.39 (3.17)	109.36 (2.65)
SES (SEM)	44.19 (5.27)	37.50 (4.72)	46.12 (6.30)	48.92 (5.39)
Diagnosis (<i>n</i>)				
Generalized Anxiety Disorder (GAD)	6	–	4	–
Social Phobia	2	–	6	–
GAD+Social Phobia	3	–	8	–
Separation Anxiety Disorder	6	–	0	–

Table 2

Mean betting-rate presented as percent (SEM) in each age-group and diagnosis by social-condition and risk-level

		<u>Children (n=30)</u>		<u>Adolescents (n=32)</u>	
		Anxious	Healthy	Anxious	Healthy
Peer-judge condition					
1-bus	94 (2)	98 (2)	97 (2)	93 (2)	
2-bus	91 (3)	95 (3)	95 (3)	94 (3)	
3-bus	90 (3)	97 (3)	95 (3)	90 (3)	
4-bus	64 (5)	89 (6)	92 (5)	72 (6)	
5-bus	39 (7)	47 (8)	59 (7)	49 (8)	
6-bus	28 (7)	32 (8)	43 (7)	31 (7)	
7-bus	15 (5)	22 (5)	30 (4)	22 (5)	
8-bus	14 (4)	15 (5)	17 (4)	18 (5)	
9-bus	12 (4)	11 (5)	15 (4)	11 (5)	
Control condition					
1-bus	94 (2)	98 (2)	96 (2)	95 (2)	
2-bus	95 (3)	92 (3)	97 (3)	92 (3)	
3-bus	89 (3)	95 (4)	92 (3)	89 (3)	
4-bus	75 (5)	76 (5)	87 (4)	72 (5)	
5-bus	51 (6)	42 (7)	58 (6)	47 (7)	
6-bus	37 (6)	29 (7)	46 (6)	46 (6)	
7-bus	28 (6)	24 (6)	26 (5)	29 (6)	
8-bus	24 (5)	18 (5)	16 (5)	24 (5)	
9-bus	18 (5)	15 (5)	12 (4)	21 (5)	

Table 3

Mean reaction time in ms (SEM) in each age-group and diagnosis by social-condition and risk level

	Children (<i>n</i>=30)		Adolescents (<i>n</i>=32)	
	Anxious	Healthy	Anxious	Healthy
Peer-judge condition				
1-bus	1008.41 (80.32)	884.45 (114.83)	822.79 (108.69)	826.53 (88.30)
2-bus	1067.54 (80.32)	931.90 (101.84)	946.11 (87.43)	894.69 (100.14)
3-bus	1180.99 (77.80)	1199.24 (94.74)	867.86 (95.06)	885.65 (85.08)
4-bus	1444.05 (69.69)	1204.42 (84.75)	1125.25 (74.52)	1000.51 (77.26)
5-bus	1352.81 (68.61)	1242.56 (79.43)	1176.56 (67.11)	972.58 (77.71)
6-bus	1213.30 (70.35)	1168.30 (80.39)	1153.37 (67.63)	953.57 (76.43)
7-bus	1160.83 (71.11)	1193.65 (81.55)	1226.22 (68.22)	956.63 (78.24)
8-bus	1158.53 (73.05)	1197.69 (82.96)	1090.44 (69.67)	991.25 (82.71)
9-bus	1117.89 (75.86)	1102.74 (90.22)	1202.76 (70.58)	930.57 (82.71)
Control condition				
1-bus	799.73 (80.32)	707.47 (147.03)	1055.36 (87.44)	708.57 (100.12)
2-bus	848.53 (96.09)	953.66 (87.07)	1070.17 (82.51)	929.13 (113.17)
3-bus	1057.94 (72.00)	1332.42 (101.88)	916.92 (87.46)	827.53 (85.09)
4-bus	1205.91 (69.69)	1132.45 (78.63)	1036.47 (69.67)	972.86 (77.25)
5-bus	1287.48 (68.61)	1231.40 (78.63)	1180.28 (66.65)	967.83 (77.02)
6-bus	1185.79 (68.61)	1232.50 (78.63)	1239.44 (67.06)	923.98 (76.32)
7-bus	1158.21 (70.35)	1186.03 (78.63)	1217.07 (67.63)	909.75 (76.43)
8-bus	1090.70 (69.69)	1204.42 (81.54)	1155.02 (67.63)	1006.61 (79.43)
9-bus	1043.42 (72.00)	1170.94 (81.54)	1226.06 (68.89)	1091.24 (80.88)