Peer Influence on Adolescent Risk-Taking Behavior and Its Mechanisms

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Abstract

Adolescents exhibit a greater propensity for risk-taking or reckless behavior and are more vulnerable to peer influence. Research findings from multiple perspectives, including individual traits and social interactions, demonstrate that peers exert a facilitative effect on adolescent risk-taking behavior, whereby adolescents' actions become more risky in the presence of peers. The mechanisms underlying peer influence on adolescent risk-taking behavior can be elucidated across psychological, neurobiological, genetic, and sociocultural levels: at the psychological level, this influence originates from adolescents' need for peer approval and belongingness, as well as social learning processes; at the neurobiological level, it stems from the interaction between cognitive control networks and stimulus processing systems; at the genetic level, it arises from susceptibility associated with specific genes; and at the sociocultural level, peer influence manifests with varying degrees and expressions due to cultural differences. Future research should thoroughly investigate the influence of peers on adolescent risk-taking behavior from developmental, cultural-psychological, and complex model network construction perspectives.

Full Text

The Influence of Peers on Adolescent Risk-Taking Behavior and Its Mechanisms

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Abstract: Adolescents are more likely to engage in risky or reckless behaviors and are more susceptible to peer influence. Research examining multiple

perspectives, including personal traits and social interactions, demonstrates a facilitating effect of peers on adolescent risk-taking behavior, such that adolescents behave more riskily when peers are present. The mechanisms underlying peer influence on adolescent risk-taking can be explained at multiple levels: psychologically, this influence stems from adolescents' need to seek peer recognition and belonging, as well as the role of social learning; at the neural level, it arises from interactions between cognitive control networks and stimulus processing systems; at the genetic level, it reflects susceptibility associated with specific genes; and at the sociocultural level, peer influence produces variations in degree and manifestation across different cultural contexts. Future research should further explore peer influences on adolescent risk-taking from developmental, cultural-psychological, and complex model network perspectives.

Keywords: adolescents, peers, risk-taking behavior, dual-system model
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1. Introduction

Risk-taking represents a choice with varying probabilities of positive or negative outcomes [**?**]. Depending on the severity of potential consequences and the relative social acceptability of the behavior, risk-taking behaviors can be categorized as either positive or negative [**?**].

Adolescence represents a unique developmental period characterized by rapid but still immature social, emotional, and cognitive development. Individuals in this stage are more likely than adults to engage in risky behaviors [**?**], such as smoking, alcohol consumption, and dangerous driving, which have serious negative consequences for adolescent physical and mental health [**?**]. From childhood to adolescence, the amount of time spent with same-sex peers increases gradually, peaking in mid-adolescence (around age 14) [**?**]. Peers play a crucial role in adolescent development [**?**]. In a review of behavioral genetics research, Harris [**?**] analyzed the influences of parents and peers on adolescent behavior, concluding that approximately 50% of variation in adolescent personality is attributable to genetics, while the remaining 50% reflects environmental influences, primarily those of peers.

When adolescents commit crimes, they are typically accompanied by peers [**?**]. Analyzing firsthand data from the 2010 National Survey of Juvenile Offenders, Guan [**?**] found that over 80% of juvenile crimes involved accomplices, with nearly 80% of juvenile offenses being peer-related. In the domain of risk-taking, researchers have proposed that adolescents are more likely to engage in risky behaviors precisely because they are more susceptible to peer influence [**?**]. For

instance, one study reported that adolescents made more risky decisions in a driving game when peers were present, whereas peer presence had no effect on adults' driving behavior [**?**]. Thus, explaining adolescent risk-taking from a peer perspective provides a theoretical basis for guiding adolescents to develop appropriate peer relationships and avoid inappropriate risk-taking. This paper reviews recent advances in this field, systematically examining previous empirical research from multiple perspectives to analyze the facilitating effect of peers on adolescent risk-taking, exploring the potential mechanisms underlying this effect at psychological, neural, genetic, and sociocultural levels, and finally identifying directions for future research.

2. The Influence of Peers on Adolescent Risk-Taking Behavior

Risk-taking behaviors offer significant potential benefits while simultaneously carrying negative consequences. From adolescence to adulthood, individuals show a marked decline in risk-taking when making decisions about potentially hazardous behaviors. Compared to children and adults, adolescents are more likely to engage in risk-taking behaviors such as smoking and alcohol consumption that have negative consequences for their physical and mental health [**?**]. Most risk-taking behaviors that peak during adolescence occur when adolescents are with peers [**?**]. Although a few studies have found no relationship between peers and adolescent risk-taking [**?**], the majority of behavioral research demonstrates that adolescents become more risk-seeking when peers are present, observing, communicating, or persuading [**?**, **?**, **?**, **?**, **?**]. Gardner and Steinberg [**?**] showed that under certain conditions, individuals made more risky decisions in peer groups than when completing tasks alone, and that the effect of peers on risk-taking varied with age, being more pronounced in mid-to-late adolescence than in adulthood. Previous empirical studies typically investigate peer influence by creating situations with or without peer presence and comparing differences in adolescent risk-taking across different conditions (no peer present, peer present only as observer, peer present and persuading). Based on this perspective, this paper systematically examines the effect of peers on adolescent risk-taking behavior.

2.1 The Influence of Peer Observation on Adolescent Risk-Taking Behavior

Research has found that peer observation facilitates adolescent risk-taking even when peers are not in the same room as participants. Chein et al. [**?**] used the Stoplight task to examine adolescent risk-taking. In this study, American adolescents were asked to bring two same-sex friends of the same age. In the peer observation condition, they were told that their peers would observe their behavior from an adjacent room via a monitor, whereas in the alone condition, participants completed the task without any observation. Results showed that adolescents made more risky decisions in the peer observation condition,

meaning that in the Stoplight game—where a car travels along a straight road approaching an intersection and the traffic light turns yellow—they were more likely to choose to proceed through the intersection without braking, risking a crash, rather than stopping to wait for the green light. Neuropsychological research further indicates that mere "peer presence"(with or without social learning) leads to increased adolescent risk-taking [**?**]. Somerville et al. [**?**] similarly confirmed the facilitating effect of peer observation on adolescent risk-taking. However, Defoe et al. [**?**] used the same risk-taking task (Stoplight) to investigate 327 Dutch early and mid-adolescents from various ethnic backgrounds (nearly half of participants had connections with other ethnicities) and found no significant effect of peers on risk-taking. The divergent results from studies using the same task may be attributable to differences in sociocultural context (different countries, ethnicities) and experimental situation settings. In Defoe et al.' s [**?**] study, the "alone" condition involved placing all adolescent participants in a large classroom; although they were far apart and did not communicate during the task, peers were technically present. Moreover, this "alone condition" resembled the "peer observation" condition setup in Reynolds et al. [**?**], where three conditions were established: alone, peer observation, and peer encouragement. In the peer observation condition, participants sat close to their peers in the same room (ensuring peers could see the computer screen) without any verbal or nonverbal communication, and results showed that peer observation increased adolescent risk-taking, although the difference did not reach statistical significance. Thus, different baseline settings for the "alone condition" across studies may yield different results. Kessler et al. [**?**] reported different findings. Using the Balloon Analogue Risk Task (BART)—where participants face a virtual balloon and must click a mouse to pump air into it to earn money, with each pump increasing both potential winnings and risk of the balloon exploding and losing accumulated money—they examined the effects of positive and negative feedback on peer effects in risky decision-making. The study also included two conditions (alone and peer observation) and found that after receiving positive feedback (i.e., success), participants were more likely to take risks, whereas after negative feedback (i.e., failure), they became more conservative. Moreover, condition only had an effect after success: following success, participants were more likely to continue risky gambling in the alone condition than in the peer observation condition. These results suggest that specific situational factors may moderate the effect of peers on adolescent risk-taking.

2.2 The Influence of Peer Communication and Persuasion on Adolescent Risk-Taking Behavior

When peers and adolescents are in the same room and can communicate during the task, or even provide advice, peers exert a stronger facilitating effect on adolescent risk-taking. Gardner and Steinberg [**?**] recruited college students, adults, and adolescents for their study. In the peer group condition, three participants completed a series of measures simultaneously in the same room and could communicate with each other, revealing a facilitating effect of peers on adolescent

risk-taking. Kretsch and Harden [**?**] established two conditions (alone and peer observation) and used a "rotating"design in the peer condition, where three members took turns completing decision tasks and observation tasks (Participant 1 performed the task while 2 and 3 observed, then Participant 2 performed while 1 and 3 observed, etc.). During the task, observers and participants could talk and even give advice. Results showed that adolescents made riskier decisions when peers were present and communicating, and that the closer to late adolescence, the more susceptible their risk-taking behavior was to peer influence. De Boer et al. [**?**] used the BART task to investigate risk-taking in 140 Dutch adolescents aged 12 to 15 and found that adolescents were more risk-seeking when completing the task with peers compared to alone. Lucks et al. [**?**] further examined risk-taking in adolescents aged 13 to 15 under social interaction conditions and found that social interaction substantially increased similarity in adolescent risk-taking, with most individuals adjusting their choices to match their peers. Such research often focuses on similarity in risk-taking among peers, with social learning posited as the underlying mechanism [**?**]. These studies consistently find increased adolescent risk-taking under peer communication conditions. As social interaction deepens, does risk-taking reach its maximum when peers encourage or persuade adolescents?

Reynolds et al. [**?**] used the BART task to further examine changes in adolescent risk-taking under peer encouragement conditions. The study established three conditions: alone, peer observation, and peer encouragement. In the peer encouragement condition, peers were told they would be compensated based on the adolescent' s risk-taking during the task (the riskier the participant behaved, the higher the peer' s compensation) and could encourage the participant to pump as much air as possible into each balloon. Results showed that risk-taking scores increased significantly among 183 older adolescents (ages 18–20) in the peer encouragement condition. More compelling evidence comes from Van Hoorn et al. [**?**], who provided adolescents with online peer advice rather than real-world peer observation conditions. Results showed increased adolescent risk-taking when peer advice was given. Additionally, empirical research on non-normative adolescents (those who have experienced abuse) found similar results, with increased risk-taking under peer encouragement conditions [**?**].

In summary, adolescents tend to make riskier decisions when peers are present. Moreover, different manipulations of the "peer presence" independent variable —that is, different situational settings across studies (from peer observation to peer communication to peer persuasion)—reflect varying depths of social interaction. From a social interaction perspective, the facilitating effect of peers on adolescent risk-taking becomes more pronounced. However, the lack of standardized settings for different conditions across these empirical studies may be one reason for contradictory results. In some studies, the "alone" condition actually involved multiple participants (including acquainted peers) completing tasks in the same room, meaning peers were technically present. Future research should avoid such confounds.

2.3.1 The Role of Individual Factors

From the perspective of personal traits, different individuals exhibit varying susceptibility to peer influence. Consequently, when facing identical peer influence situations, adolescents with different resistance levels may show different risk-taking tendencies. Chein et al. [**?**] found that adolescents' sensitivity to social environments was significantly negatively correlated with self-reported resistance to peer influence (RPI), and that peer presence transformed adolescents' reward sensitivity into significantly increased risk-taking. Peake et al. [**?**] examined adolescents' risk-taking decisions following social exclusion and found that adolescents with low self-reported RPI engaged in more risk-taking. Adolescents' ability to resist peer influence shows unique developmental characteristics. Steinberg and Monahan [**?**] proposed that previous research on risk-taking and antisocial behavior described adolescent susceptibility to peer pressure as an inverted U-shaped curve peaking around age 14, whereas their own research found that resistance to peer influence increased linearly between ages 14 and 18, with little growth between ages 10–14 or 18–30. Thus, mid-adolescence represents a particularly important period, and future research on the relationship between peers and risk-taking should focus on adolescents in mid-to-late adolescence. From a gender perspective, male adolescents are more likely than females to make risky decisions in the same situations. De Boer et al. [**?**] found that adolescents took much greater risks when completing risk-taking tasks with peers, and that boys took more risks than girls under these conditions. Similarly, although Defoe et al. [**?**] found no significant main effect of peer presence, their results showed a moderating effect of gender. When boys and girls completed the Stoplight game alone, their risk-taking levels were comparable, but when boys completed the task with two same-sex peers, boys were more likely to take risks than girls. These results indicate that gender can determine whether social contexts (i.e., peer presence) influence risk-taking in early and mid-adolescence.

2.3.2 The Role of Different Situations

Researchers have also examined the role of peers across different situational contexts. First, regarding situational certainty, Lloyd and Döring [**?**] explored the influence of peer group contexts on adolescent risk-taking and found that adolescents were more susceptible to peer influence and became more risk-seeking when in ambiguous situations. Previous research has also found that adolescents are more likely to choose risky options when in ambiguous situations [**?**]. Second, regarding forms of peer participation, Victor et al. [**?**] recruited adolescents aged 18–19, classified them into low-risk and high-risk groups based on personality tests, and compared their performance on the Stoplight task under two different social conditions (competitive vs. non-competitive). Although behavioral results showed no group-specific effect of peer competition, they found that adolescents with stronger resistance to peer influence took more risks under peer competition conditions. fMRI results revealed that when high- and low-risk groups were defined by actual task performance, the low-risk group showed

more pronounced activation in two regions of the left medial prefrontal cortex (PFC), while peer competition increased relevant activation in the right caudate nucleus across the entire sample, further indicating enhanced reward processing in adolescent risk-taking under peer influence.

3. Mechanisms of Peer Influence on Adolescent Risk-Taking Behavior

Existing empirical research has reliably established the facilitating effect of peers on adolescent risk-taking, with peer influence on individual risk-taking being greater during adolescence than during childhood or adulthood [**?**]. What, then, are the mechanisms underlying peer influence on adolescent risk-taking? Early research focused on identifying cognitive immaturity as the cause of adolescents' high risk-taking tendencies [**?**], but later experiments comparing adolescents'and adults' abilities to perceive and process basic components of risk information found that adolescents could assess risk in decision-making as accurately as adults [**?**]. Current empirical research supports the premise that adolescents exhibit only minor deficiencies in general cognitive skills compared to adults. Therefore, age differences in risk-taking may be better understood from a psychosocial functional perspective.

3.1 Psychological Mechanisms of Peer Facilitation of Adolescent Risk-Taking

First, the facilitating effect of peer presence on adolescent risk-taking reflects adolescents' need for peer recognition. Extensive literature shows that others' behavior significantly influences individual performance [**?**, **?**, **?**]. When with others, individuals modify their actions to align with those around them. Adolescents seek conformity with peers not because they trust peer evaluations more than adult evaluations, but because they desire acceptance by the peer group [**?**]. Alternatively, peer presence provides adolescents with a special social cue that leads them to adopt risk-taking as a way to demonstrate personal qualities and seek peer recognition [**?**]. Sherman et al. [**?**] examined the unique ways peer influence occurs on social media and found that adolescents preferred photos labeled with more "likes" from peers, demonstrating the influence of virtual peer recognition, with similar effects found in responses to photos depicting risk-taking behaviors (e.g., drinking, smoking).

Second, the facilitating effect of peers on adolescent risk-taking may stem from adolescents' strong sense of belonging to peer groups. During adolescence, peer groups form the foundation for identity development [**?**]. Social identity serves as a mechanism through which adolescents connect with peers, fostering a sense of belonging conducive to personal development [**?**]. Adolescents' behavior is more susceptible to peer influence, and the nature of behavioral consequences depends on peer group norms. For example, when peer group norms favor academic and personal achievement, behavioral consequences are positive; when group norms

are associated with antisocial or risk-taking behaviors (e.g., smoking, alcohol consumption), consequences are negative [**?**].

Third, the mechanism underlying the peer facilitation effect on adolescent risk-taking may also derive from social learning from same-age peers. Toyokawa et al. [**?**] used online interactive experiments to examine "why groups of individuals sometimes exhibit collective wisdom and sometimes inappropriate madness," finding that this apparent contradiction is moderated by social learning strategies. Additionally, Knoll et al. [**?**] validated this through behavioral research. They surveyed 563 participants aged 8–59, asking them to make initial risk assessments of everyday situations, then informing them of ratings from a social influence group (adolescents or adults), and finally asking them to re-rate the same situations. Results showed that the degree to which participants changed their ratings to match others decreased from late childhood to adulthood. Most age groups adjusted their ratings to align more closely with the "adult group" ratings, with only adolescent participants being more influenced by the "adolescent group": adolescents (ages 12–14) were more likely to adjust their ratings to match adolescent ratings rather than adult ratings, indicating that adolescents are more susceptible to same-age peers than to adults. Subsequent research by Knoll and colleagues [**?**] further found that children (ages 8–11) and adolescents (ages 12–14) were more susceptible to feedback from the "adolescent group" only when that group rated the same situations as significantly more dangerous. The similarity in adolescent risk-taking (with most adolescents adjusting their choices to match peers) largely reflects a social learning process whereby individuals learn about the world through information provided by others, with same-age evaluations providing adolescents with specific social cues that influence the degree of behavioral conformity. In peer presence situations, peers can communicate and interact with adolescent participants, and the information provided during this exchange may offer specific social cues that prompt adolescents to take more risks.

Finally, peer influence on adolescent risk-taking also results from heightened reward sensitivity. Gardner and Steinberg [**?**] provided experimental evidence demonstrating the strong influence of peers on adolescent risk-taking, showing that adolescents in peer contexts focus more on benefits than costs. Adolescents behave more riskily in the company of friends, partly due to the effect of peer presence on reward sensitivity. Research indicates that adolescents are more likely than adults to prefer immediate rewards over delayed rewards when with peers [**?**]. Compared to adults, the presence of same-age peers more strongly "activates" a motivational state sensitive to rewards in adolescents, which increases the subjective value of immediate rewards and thus enhances preference for short-term benefits of risky choices over long-term value of safe options [**?**].

3.2 Neural Mechanisms of Peer Facilitation of Adolescent Risk-Taking

The dual-system model suggests that increased risk-taking during adolescence results from an imbalance between affective/motivational and deliberative pro-

cesses [?]. At the neural level, this imbalance manifests as both immaturity of the prefrontal cortex and hyper-responsivity in reward-related regions [?, ?, ?]. Adolescence is marked by profound reorganization of brain regions necessary for cognitive maturation, executive function, working memory, reward processing, emotional regulation, and motivated behavior [?]. As adolescents' cognitive structures gradually mature, their nervous systems undergo significant changes: cognitive control regions such as the prefrontal cortex and anterior cingulate cortex develop slowly, not fully maturing until late adolescence [?], while affective regions such as the ventral striatum (which plays an important role in the dopaminergic reward system) develop rapidly [?]. According to many research groups [?, ?, ?, ?, ?], the neural mechanisms through which peers prompt adolescents to take more risks involve two systems and their joint action: a stimulus processing system involving the ventral striatum (VS) and orbitofrontal cortex (OFC), biased toward decision-making based on evaluation and prediction of potential rewards and punishments; and a cognitive control system including the lateral prefrontal cortex (LPFC), medial prefrontal cortex (MPF), and dorsolateral prefrontal cortex (DLPFC), which support goal-directed decision-making through mental mechanisms for impulse control and deliberation of alternative choices. The primary component of the VS is the nucleus accumbens (NAcc), which is hypersensitive to rewards during adolescence, with its activity peaking during this period [?].

First, one neural mechanism underlying peer facilitation of adolescent risk-taking involves the cognitive control network. Sherman et al. [?] found that adolescents preferred photos of risk-taking behaviors that had been "liked" by more peers, and that activation in their cognitive control network decreased when viewing such photos. Knoll et al. [?] used a risk-rating behavioral paradigm to investigate the neural mechanisms of social influence on risk perception in female adolescents (ages 12–14) and adults (ages 23–29). Results showed that female adolescents were more likely than adults to adjust their ratings to align with others. When conflicts existed between participants' own ratings and social influence group ratings, activation increased in the posterior medial frontal cortex, dorsal cingulate cortex, and inferior frontal gyrus in both age groups, indicating that the medial prefrontal cortex (MPF) is sensitive to both social conflict and social influence. Meanwhile, the posterior medial prefrontal cortex (pMFC) plays an important role in processing social contexts. Engelmann et al. [?] showed that providing adolescents with peer advice increased their risk-taking, whereas risk-averse advice typically provided by adults decreased it, with neuroimaging results indicating that advice effects were mediated by modulation of DLPFC activity. Specifically, advice increased the strength of association between DLPFC brain activity in adolescents and parameters reflecting safe choices. Other researchers have investigated neural mechanisms of peer influence on adolescent risk-taking from different angles; Peake [?] found that when making risky decisions following social exclusion, adolescents with low resistance to peer influence (RPI) showed higher activation in the right temporoparietal junction (rTPJ), with this response in rTPJ serving as an important mediator

between RPI and greater risk-taking after social exclusion. These results suggest that mentalizing and/or attention mechanisms have a unique direct effect on adolescents' susceptibility to peer-influenced risk-taking. In summary, brain regions and networks related to cognitive control, such as the PFC and mPFC, play a role in the relationship between peers and adolescent risk-taking. First, adolescents' cognitive control systems are inherently less mature than adults' ; second, when real or virtual peers are present, activation in adolescents' cognitive control networks decreases while they view photos of risk-taking behaviors or personally experience risk-taking.

Second, the neural mechanisms underlying peer facilitation of risk-taking also involve the stimulus processing system related to rewards. Decision-making is a product of both cognitive and emotional inputs, and peer presence makes adolescents more risk-seeking, possibly reflecting a reward-sensitive state. Researchers have found that conforming to group opinions is often associated with activation in reward-related brain regions in adults (VS, including NAcc) [**?**]. Meanwhile, responses to reward-related cues and reward anticipation are particularly pronounced during adolescence [**?**]. Given that adolescents value the rewarding nature of peer interaction, peer presence may sensitize their incentive processing system to respond to cues of potential rewards from risk-taking behaviors. Chein et al. [**?**] found that when adolescents completed the Stoplight risk-taking task under peer observation conditions, reward-related brain regions, including the VS and OFC, showed selectively greater activation, with activity in these regions predicting subsequent risk-taking. Peake [**?**] found in experimental research examining the relationship between peers and adolescent risk-taking that safe decisions (Stoplight task, Stop > Go) produced more activation in the LPFC, whereas risky decisions (Stoplight task, Go > Stop) produced more activation in the VS. Braams et al. [**?**] further validated the peak in NAcc activity during adolescence through a two-year longitudinal study of individuals aged 8–27, collecting neural responses to rewards, pubertal development (self-reports and testosterone levels), laboratory risk-taking (BART task), and self-reported risk preferences (Behavioral Inhibition System/Behavioral Activation System questionnaires) at two time points. Longitudinal analyses confirmed a quadratic age pattern in NAcc activity in response to rewards (peaking during adolescence), with the same quadratic age pattern for laboratory risk-taking decisions (BART). Changes in NAcc activity were further correlated with changes in testosterone and self-reported reward sensitivity (BAS-Drive), highlighting the critical roles of pubertal hormones and individual differences in risk-taking tendencies. In summary, when peers are present, adolescents' increased risk-taking directly reflects the involvement of reward-related stimulus processing systems. Peer presence stimulates adolescents' brain reward systems, producing greater activation. Even if adolescents' cognitive control network activation remains unchanged during this process, the greater activation of the reward system makes them more susceptible to emotional influences and more likely to make less rational risky decisions.

3.3 Genetic Mechanisms of Peer Facilitation of Adolescent Risk-Taking

In the domain of risk-taking, the degree to which adolescent behavior is influenced by peers has a genetic basis. Previous empirical research has focused on the serotonin system, specifically the serotonin transporter-linked polymorphic region (5-HTTLPR). Homberg et al. [**?**] examined the relationship between risk-taking decisions and 5-HTTLPR in healthy adult women using the Iowa Gambling Task (IGT) and found that participants with homozygous short alleles (s/s) selected cards from disadvantageous decks more frequently than those with homozygous long alleles (l/l) or heterozygotes (l/s), indicating that individuals carrying homozygous short alleles are more prone to risk-taking. At the individual level, researchers have found a direct association between short alleles and risk-taking. Furthermore, in research on the facilitating effect of peers on adolescent risk-taking, genetic factors also play a special role. Daw et al. [**?**] showed that while adolescents in schools with higher rates of tobacco and alcohol use were more likely to smoke and drink, more importantly, adolescents' susceptibility to school smoking or drinking patterns also depended on the number of short alleles they possessed in the 5-HTTLPR. Subsequent research in the neighborhood peer context yielded similar results. Daw et al. [**?**] conducted longitudinal measurements of cigarette use among 6th to 8th grade students across 82 neighborhoods, with genetic data available for 1,098 participants. Results showed that neighborhood peer smoking was a significant predictor of individual adolescent cigarette use initiation, and that the risk of smoking was significantly elevated for individuals with homozygous short alleles of 5-HTTLPR in high-smoking neighborhoods compared to low-smoking neighborhoods and/or individuals without short alleles. Both individual-level studies and research on the relationship between peers and adolescent risk-taking reflect the specificity of 5-HTTLPR short alleles and further validate that carriers of 5-HTTLPR short alleles are sensitive to environmental influences.

Additionally, beginning in adolescence, brain affective regions centered on the ventral striatum develop rapidly and play an important role in the dopaminergic reward system. This suggests that dopamine may be specific to risk-taking. Another factor affecting cortical function and top-down control of subcortical regions is the COMT Val158Met polymorphism (catechol-O-methyltransferase Val158Met), whose role warrants attention. COMT is the primary dopamine (DA) degradation enzyme in the prefrontal cortex region. Webber et al. [**?**] created a polygenic risk index (PGR) using COMT Val158Met polymorphism, ANKK1 Taq1A polymorphism, and dopamine receptor gene DRD2_{141C} Ins/Del, classifying participants into positive polygenic risk (PGR+) and negative polygenic risk (PGR-) types. COMT has three genotypes: Met/Met, Val/Met, and Val/Val, with risk indices decreasing progressively. Results showed that adolescents engaged in more risk-taking when peers were present, but the genetic risk index did not significantly moderate the relationship between peer presence and adolescent risk-taking. Webber et al.' s [**?**] study

combined COMT Val158Met, ANKK1 Taq1A, and DRD2_{141C} Ins/Del for analysis without separately testing COMT Val158Met polymorphism. In previous research, Bos et al. [?] examined the interactive effects of COMT Val158-Met polymorphism and 5-HTTLPR on participants' risk-taking, where 5-HTTLPR included l/l, l/s, and s/s genotypes, and COMT included Met/Met, Val/Met, and Val/Val genotypes. The study showed that s/s-Met/Met participants performed worst among all possible combinations of 5-HTTLPR and COMT allelic variants. However, researchers did not focus on the relationship between peers and adolescent risk-taking, so whether the risk-taking of s/s-Met/Met carriers is more susceptible to peer influence remains to be verified in future research.

3.4 Sociocultural Mechanisms of Peer Facilitation of Adolescent Risk-Taking

Most research on the relationship between peers and adolescent risk-taking has been conducted in Western contexts. In Chinese contexts, researchers have also found specific effects of peers on adolescent risk-taking. Tian et al. [?] used questionnaire methods to survey 689 adolescent students from regular high schools and vocational schools and found that positive peer pressure could significantly predict socially acceptable risk-taking in regular high school students. In subsequent experimental research using event-related potential (ERP) technology and the Balloon Analogue Risk Task (BART), they found that adolescents engaged in more risk-taking under peer presence conditions compared to no-peer conditions [?]. As mentioned earlier, in Western contexts, Chein et al. [?] using the Stoplight task found that adolescents made more risky decisions under peer observation conditions, and Somerville et al. [?] similarly confirmed the facilitating effect of peer observation on adolescent risk-taking. Other researchers have also found that peer presence makes adolescent behavior more risk-seeking [?, ?, ?]. These findings indicate that peer influence on adolescent risk-taking has some universality across different sociocultural contexts in the East and West.

Do adolescents from different sociocultural backgrounds experience peer influence to different degrees? Gardner and Steinberg [?] found that the effect of peers on risk-taking varied by ethnicity. Specifically, non-White adolescents' risk-taking was more susceptible to peer influence than that of White adolescents. The effect of peers on risk preference was larger among non-White adolescents than White adolescents, though non-White adults were less influenced by peers. Unger et al. [?] assessed the relationship between adolescent smoking and peer smoking among adolescents in California, USA, and Wuhan, China, and found that adolescent smoking was strongly associated with peer smoking in both samples, with no difference in the strength of this association between the two cultures. However, Liu et al. [?] conducted a meta-analysis examining the relationship between peer smoking and adolescent smoking initiation and continuation. This analysis included 75 longitudinal studies from 16 countries

worldwide and found that adolescents with smoking peers were twice as likely to start and continue smoking compared to those without smoking peers. Moreover, the positive correlation between adolescent smoking initiation/continuation and peer smoking was stronger when samples came from collectivist cultures (versus individualist cultures). Li and Fang [**?**] showed that Chinese participants with more social support did not choose riskier options. The Chinese sociocultural context emphasizes "harmony and stability" and upholds collectivist culture. For example, when making decisions in real life, individuals often consider their social networks, and pressure from peers or relatives may lead them to avoid risk-taking; conversely, help from peers or relatives may also make them more risk-seeking. However, cross-cultural research examining peer influence on adolescent risk-taking is limited, and few empirical studies have directly compared which adolescents in Eastern versus Western cultural contexts are more susceptible to peer influence and whether the mechanisms of this effect differ, requiring verification in future empirical research.

4. Summary and Outlook

The high incidence of adolescent risk-taking is inseparable from the special psychological and physiological developmental characteristics of adolescence, with peers representing a particularly important factor. This paper elaborated on the influence of peers on adolescent risk-taking from multiple perspectives, including personal traits and social interaction, and explored the potential mechanisms of this influence at psychological, neural, genetic, and sociocultural levels.

Current research still has several limitations, and future studies could pursue more in-depth exploration from the following aspects. First, developmental perspectives should be used to investigate peer influence on adolescent risk-taking. Generally, adolescence can be divided into early, middle, and late stages according to age. As mentioned earlier, adolescents' susceptibility to peer pressure shows developmental characteristics across different stages of adolescence, with a turning point occurring in mid-adolescence. Moreover, the peak in time spent with same-sex peers also occurs in mid-adolescence. Therefore, the effect of peers on risk-taking may differ across adolescent stages, possibly substantially. However, previous researchers in this field have not paid sufficient attention to this issue, leading to contradictory findings and making it difficult for subsequent researchers to directly compare previous results. Thus, future research needs to further verify the effect of peers on adolescent risk-taking at different stages of adolescence.

Second, adolescent risk-taking should be investigated from a perspective combining genetics and environment. Genetic-level research can reveal individual susceptibility to environmental influences. With advances in genetic research, current studies have demonstrated the specificity of the serotonin transporter-linked polymorphic region (5-HTTLPR), showing that short allele carriers' risk-taking is more susceptible to peer influence [**?**, **?**]. However, empirical findings in this area remain limited. Future research could explore the genetic mech-

anisms of peer influence on adolescent risk-taking from a multi-locus genetic perspective, potentially enabling genetic screening to predict which adolescents are susceptible to peer influence, allowing for early identification and intervention to avoid serious negative consequences. Environmental-level research could further explore the mechanisms of peer influence on adolescent risk-taking from a sociocultural perspective. Although few direct cross-cultural studies have compared Eastern and Western cultures, existing empirical research has confirmed the stability of peer effects on adolescent risk-taking across different cultural contexts. Future research could examine differences in the degree and mechanisms of peer influence on adolescents across cultural contexts from a cultural psychology perspective. Combining genetics and environment to further explore peer influence on adolescent risk-taking is also an important direction for future research.

Finally, research domains should be expanded to deeply investigate the role of other factors and construct a model network of peer influence on adolescent risk-taking. Previous studies have examined the roles of gender, situational factors, and other variables, which based on descriptive results may play moderating roles, though these studies did not provide rigorous verification. Previous empirical research has also rarely controlled for peer relationship factors—for instance, some studies had adolescents bring peers who were merely acquaintances, while others involved close friends. Future research could adopt a model network perspective to deeply investigate the specific roles played by factors such as peer relationships and individual characteristics, such as mediating effects, moderating effects, or more complex models.

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Note: Figure translations are in progress. See original paper for figures.