# UNIVERSITY OF PAVIA – IUSS SCHOOL FOR ADVANCED STUDIES PAVIA

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# Friend or Foe? Social Integration and Coordination Strategies in Young Adolescents


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# Abstract

This study investigates the interplay between adolescents' decision-making strategies in competitive, cooperative, and lottery-based contexts and their social integration with peers. Using a sample of 177 Italian adolescents, the research explores how behaviors in controlled game-theoretic environments relate to peer nominations in classroom settings. The results reveal that competitive risk-taking and response variance are significantly associated with an increase in "least liked" nominations, indicating that adolescents who take more risks and who display less response variance in competitive situations are more likely to be rejected by their peers. Conversely, cooperative risk-taking was not associated with social integration. To our knowledge, this is the first study to document a link between behavior in economic games and ecological social outcomes crucial to adolescent well-being, such as peer integration. These findings suggest that adolescents' success in peer integration is partly reflected in how they engage with simplified coordination problems involving anonymous others in controlled settings. This sheds light on promising new avenues for studying the cognitive bases of social integration during adolescence, providing a novel perspective on how competitive behaviors may shape social standing and peer relationships during this developmental stage.

# Introduction

Adolescence is a critical period of social reorientation, encompassing neurobiological, cognitive, and social changes. During this stage, individuals transition from a reliance on caregivers to a greater dependence on peer relationships, navigating a landscape where social interactions become increasingly complex and nuanced. This developmental phase is characterized by heightened neuroplasticity, particularly within brain regions responsible for social cognition and emotional regulation, making it a sensitive period for social development (Becht et al., 2021; Fuhrmann et al., 2015; Larsen & Luna, 2018).

There has been a significant divide in the literature in the study of social behavior. On the one hand, social development research has focused on social functioning within ecological niches, such as the classroom, emphasizing the importance for adolescents of peer acceptance, sociometric status, and real-world social integration (Jiang & Cillessen, 2005; Lemann & Solomon, 1952; McMullen et al., 2014). This line of inquiry typically examines how adolescents are perceived by their peers, exploring the determinants of being liked or disliked and their implications on social standing and mental health. Sociometric measures, such as peer nominations, provide valuable insights into the dynamics of adolescent social hierarchies and their long-term effects on individual development (Bukowski et al., 2017; Carlson et al., 1984).

On the other hand, another body of literature investigates social behavior through the lens of game-theoretic paradigms. These paradigms, such as competition and competition games, offer a controlled environment to study social decision-making processes. They focus on the strategic reasoning that underlies cooperative and competitive behaviors, allowing researchers to isolate specific variables and understand the cognitive mechanisms driving social interactions (Camerer,

2003; Chierchia et al., 2018). While these studies provide a precise and quantifiable approach to understanding social behavior, they often lack the ecological validity of studying interactions in naturalistic settings.

Despite the valuable insights offered by both approaches, there has been a notable lack of communication between these two worlds, leading to a fragmented understanding of adolescent social development. This gap is particularly intriguing given that both approaches ultimately aim to understand the same phenomena: how people navigate their social environments.

This dissertation seeks to bridge the gap between controlled experimental findings and real-world social functioning by exploring the relationship between social coordination strategies, as measured by game-theoretic paradigms, and peer relationships, as understood through sociometric measures in ecological settings. Adolescence is a critical period for social development, characterized by a shift from reliance on caregivers to greater dependence on peers. This reorientation is reflected in how adolescents engage in cooperative, competitive, and uncertain social contexts, which are central to their ability to navigate complex social environments. The process of socialization plays a key role in this transition, as adolescents learn the behaviors and norms that affect their peer relationships and social standing.

The neural developments that occur during adolescence, particularly in areas related to social cognition, support the growing sophistication of social decision-making. Adolescents' ability to differentiate between cooperative and competitive contexts, as well as their propensity for sensation-seeking and risk-taking, directly influences their peer integration. These behaviors, often studied in controlled game-theoretic paradigms, provide insight into how adolescents approach social coordination and how these strategies translate into real-world social outcomes.

Ultimately, this study aims to provide a more integrated understanding of how social decision-making during adolescence impacts social integration and overall well-being. By examining the interplay between controlled experimental settings and ecological social contexts, this research highlights the importance of coordination strategies in shaping peer relationships and social success during this pivotal developmental stage.

## Social development During Adolescence

Humans socialize with each other because they are inherently social animals, requiring skills to coordinate and interact effectively within social groups. This ability to cooperate and form large-scale networks beyond kin has been crucial to our success as a species. The process through which new group members adopt the group's beliefs, behaviors, and values, along with the corresponding emotional and cognitive aspects, is known as socialization (Grusec, 2017). Human socialization is believed to begin at birth (Bjorklund et al., 2010) and continues throughout life, adapting to different ages, contexts, environments, and people. The first stage of socialization is sometimes called primary socialization, and it occurs in childhood, with the inner family acting like a miniature version of society. During this age, children can receive unconditional love and support from their parents, without competing interests with them —at least not until they become adolescents (Anastasiu, 2011). As they grow older, children start to move into secondary socialization, which is characterized by increased interactions with other socialization agents such as teachers, peers, and the media. In this stage, children must play a more active role to be integrated into a group of friends or classmates (Maccoby, 2015). This period of middle childhood and adolescence, where children navigate between different types of socialization, has been extensively studied. Some theories propose that this stage is when children are most responsive to environmental influences, as innate tendencies begin to surface, or when developmental pathways

are more clearly shaped by a combination of biological, psychological, and social factors (Handbook of Socialization, 2015).

Particularly, adolescence is a period marked by significant transformation, during which people experience profound changes in their bodies, minds, and social lives. This phase is driven by hormonal shifts, brain development, and a shifting social focus from family to peers, a process frequently called social reorientation (van den Bos, 2013). The hormonal shifts, primarily due to an increase in gonadal steroids, play a pivotal role in triggering the development of secondary sexual characteristics and significantly influences mood and behavior.

Brain development during this age has been suggested to contribute to a sensitive or even critical period for executive function development (Larsen & Luna, 2018), and especially for the development of socio-cultural cognition (Fuhrmann et al., 2015). Critical periods are developmental stages when the brain is particularly receptive to specific stimuli, traditionally known in neurobiology for vision and language (Daw, 2006). Researchers propose that adolescence may also be a sensitive period for higher-order cognitive processes such as inhibitory control and socio-cultural processing, including cooperation and competition (Larsen & Luna, 2018; Fuhrmann et al., 2015; Walasek, 2022). Broadly, grey matter volume decreases and white matter increases, with social experiences being particularly important for shaping these changes (Becht et al., 2021; Fuhrmann et al., 2015). In terms of white matter development, recent studies suggest that brain regions associated with motor functioning develop earlier in childhood, while areas linked to higher-order cognition, particularly social cognition, continue to mature throughout adolescence. This aligns with the idea that adolescence is a critical period for the development of social and cognitive skills, as the brain areas involved in social processing reach their peak development during this time (Barnea-Goraly et al., 2005).

To understand the healthy developmental trajectory of adolescence, it is crucial to examine the shift in social dynamics from caregiver reliance to peer reliance. In particular, mid-adolescence is a transitional phase in which adolescents (over the age of ten) spend more time with their peers than with their parents and develop deeper peer relationships (Orben et al., 2020). These relationships mutually influence one another, with the nature of this influence evolving as adolescents progress through different stages of development. Indeed, research supports both the parent effect model, which emphasizes the influence of parent-child and parent-adolescent relationships on friendships, and the friend effect model, which highlights how friendships can, in turn, affect parent-child and parent-adolescent dynamics. In early to middle adolescence, the parent effect model is more influential, whereas in middle to late adolescence, both models have been suggested to exert more comparable influence. Adolescents who perceive their parents as supportive also view their friends as supportive (De Goede et al., 2009). Their attachment style also plays a role in their friendships, where adolescents with secure attachments demonstrate greater intimacy with peers, while those with insecure, avoidant, or ambivalent attachments struggle with intimacy and developing competencies necessary for sharing ideas and feelings (Delgado et al., 2022). Positive interactions with parents serve as models for resolving conflicts with peers effectively. Negative interactions that are characterized by increased conflict and decreased closeness negatively impact adolescent social development (Steinberg & Morris, 2001), at a time when heightened brain plasticity makes the brain especially sensitive to experiences and environmental demands (Pascual-Leone et al., 2005). This plasticity is not only shaped by experiences but also anticipates exposure to certain stimuli, making adolescence a particularly critical period for social and cognitive growth. During adolescence, plasticity is experience-dependent and experience-expectant, meaning that the brain "expects" exposure to specific stimuli,

making this a sensitive period for brain development (Fuhrmann et al., 2015). The relevant brain systems are grouped into 3 networks, detection, affective, and cognitive nodes by Nelson and colleagues (2005). The detection node, which begins to categorize social and non-social stimuli before adolescence, continues to develop throughout this period (Halit et al., 2003). Once a stimulus is identified as social, the affective node assigns emotional significance by determining whether it is approachable or should be avoided. The brain areas that are part of this node such as the striatum, ventral tegmental area, and amygdala, develop during adolescence with a major influence from gonadal hormones (E. E. Nelson et al., 2005; Pujara & Koenigs, 2014). This development contributes to the emotional variability often observed during this period (Larson et al., 2002). Lastly, the cognitive node processes the social inputs through functions like Theory of Mind, inhibitory control, and goal-directed behaviors which are crucial for social decision-making and awareness.

The intricate interplay between brain development and social dynamics during adolescence sets the stage for critical changes in how individuals interact with their environment. As adolescents become increasingly attuned to social stimuli, the maturation of brain regions involved in emotional regulation and cognitive control significantly impacts their social decision-making. This evolving capacity for processing social information is not only a response to familiar social contexts but also a crucial factor in how adolescents navigate new and uncertain social situations. One key aspect of this developmental process is the heightened sensation-seeking behavior observed during adolescence, which plays a pivotal role in both social exploration and the balance between risk and reward in peer interactions.

## Sensation-seeking

A noteworthy feature that increases during adolescence is sensation-seeking, a desire for novel and exciting experiences. Adolescents often engage in risky behaviors as this is the developmental peak for their sensation-seeking propensity. While sensation-seeking can be a normal and adaptive part of discovering and testing boundaries, it can also lead to detrimental risky behaviors (Steinberg et al., 2018).

The dual-systems paradigm offers a useful framework for understanding adolescent risk-taking behavior, where the faster development of the reward-seeking system outpaces the slower maturation of the cognitive control system (Shulman et al., 2016). This phenomenon is explained by heterochronicity—the asynchronous development of brain regions—which results in an imbalance between the impulse-driven reward system and the more deliberative cognitive control system (Banich & Floresco, 2019). The brain networks associated with functions like impulse regulation develop slower than other regions and are less influenced by hormonal changes (E. E. Nelson et al., 2005), leading to heightened sensation-seeking behavior. This developmental imbalance not only contributes to risk-taking but also plays a significant role in how adolescents navigate social uncertainty, particularly as they increase their interactions with peers.

From an ontogenetic perspective, sensation-seeking may be heightened during adolescence as a means of promoting exploration, including social exploration. This allows individuals to test their abilities in new and uncertain situations, gaining crucial social and coordination skills. While these behaviors are not inherently negative, in peer-influenced environments they can lead to riskier decisions, such as drug use or reckless behavior (Littlefield et al., 2016). However, more pertinent to understanding the association between coordination abilities and social integration is the growing sophistication of adolescents' social behavior. Adolescence is marked by substantial

improvements in socio-cognitive abilities, such as mentalizing and abstract reasoning, which are key to strategic social decision-making. As adolescents mature, they become increasingly adept at differentiating between cooperative and uncooperative peers, directing prosocial behaviors toward friends, especially those who reciprocate their friendship (Burnett Heyes et al., 2015; van de Groep et al., 2020). Adolescents also become more sensitive to the intentions behind others' actions, adjusting their behavior based on observed friendliness or hostility (López-Pérez et al., 2023; Westhoff et al., 2020). These developments suggest that adolescence is a critical period for honing the ability to adapt social behaviors in response to social cues and the uncertainty of peer interactions, which plays a crucial role in navigating relationships and achieving social integration. As adolescents' social behavior becomes more attuned to their environment, their coordination abilities—whether in cooperative or competitive contexts—become integral to how they interact with others, ultimately influencing their social standing and peer relationships.

In conclusion, adolescence represents a critical period of social reorientation where the dynamics of cooperation, competition, and social integration play vital roles. Positive social interactions and stable friendships significantly enhance resilience, brain plasticity, and overall mental health, fostering environments conducive to healthy development. Conversely, unsuccessful socialization and social deprivation can lead to detrimental outcomes, including poor mental health and socioemotional difficulties. Understanding these processes is essential to support adolescents in navigating this transformative stage, promoting their growth into well-adjusted adults who can effectively balance competition and cooperation within their social contexts. The literature reviewed thus far suggests that adolescence is a particularly sensitive period for social development, during which the ability to strategically differentiate between cooperative and competitive peers becomes increasingly important. This points to a potential

connection between social integration and coordination abilities. To explore this further, we will first examine each of these components—social integration and coordination strategies—as they are typically investigated in their respective fields, before returning to how they may be interconnected in adolescence.

## Social Integration

Social integration during adolescence is deeply influenced by the behaviors exhibited by youths in various settings, particularly in school, where they typically spend much of their time. Prosocial behaviors, including acts of kindness and cooperation, tend to elevate an adolescent's social standing, leading to greater acceptance and stronger peer relationships. Conversely, antisocial behaviors, such as aggression and hostility, often result in peer rejection, which can have lasting negative effects on social dynamics, cognitive development, and overall well-being (Walker, 2009).

Researchers studying social integration often rely on sociometric methods, like peer nominations, to assess these dynamics within naturalistic contexts. These assessments provide valuable insights into the complexities of adolescent social interactions, capturing how behaviors like cooperation and aggression influence peer acceptance, rejection, and the broader social standing of individuals. By understanding these factors, we can better grasp the determinants of social integration and the long-term implications for adolescents' social and academic outcomes.

One approach that researchers take when studying social development is through ecological measurements in real-world settings, such as peer and sociometric assessments. School environments, where adolescents spend much of their time, provide an ideal setting for these assessments, facilitating peer evaluations and researcher observations. By observing and analyzing

peer interactions, researchers gain a comprehensive understanding of students' social experiences and the factors that influence their social standing and relationships. These methods provide critical insights into the social structures, relationships, and behaviors of students, enabling the identification and remediation of issues related to peer acceptance, rejection, and overall social integration (Jiang & Cillessen, 2005; Lemann & Solomon, 1952; McMullen et al., 2014). Given the significant influence, peers have on adolescents' development, sociometric methods are highly effective for measuring peer relations and have become prominent in research on adolescent's social development. For decades, researchers have explored various aspects of sociometric status, including its relationship with concurrent social behaviors (Kupersmidt & Coie, 1990) and its ability to predict future social and academic adjustment (Boivin et al., 1995; Rubin & Daniels-Beirness, 1983).

Peer nominations, or peer assessments, are popular in sociometric research to assess different social characteristics and statuses in youths. Participants in these methods nominate or rate their peers according to specified criteria, such as popularity, likeability, or behavioral features (Bukowski et al., 2017). The number of these nominations can be fixed or unlimited, the former could simplify the process, but it could potentially overlook some social relationships. Unlimited nominations, on the other hand, allow for a more comprehensive assessment but can be more demanding for participants (Gommans & Cillessen, 2015).

Using these nominations researchers can identify adolescents who are well-liked (accepted), disliked (rejected), or neither liked nor disliked (neglected), offering valuable information on social status and potential risks for social and psychological issues (Carlson et al., 1984). For instance, rejected youths are often viewed by their peers as more aggressive and disruptive compared to their accepted or neglected classmates. This suggests that the low

sociometric status of rejected adolescents may be linked to the negative impact of their behavior on peers (Carlson et al., 1984).

Peer nominations are a reliable method for predicting future social and academic outcomes, but their stability can be affected by significant life changes or developmental stages, as noted by Jiang and Cillessen (2005). However, the validity of these nominations can vary across cultures because terms like "popularity" may have different meanings in different languages, potentially skewing results in cross-cultural studies (de Bruyn & Cillessen, 2006; Niu et al., 2016).

## Determinants of Being Liked

Understanding the factors that predict being liked is essential for grasping social dynamics, particularly during adolescence when social integration becomes crucial. People are often drawn to those who share similar interests, physical characteristics, personality traits, or views, a phenomenon known as homophily (Montoya et al., 2008). This similarity can either be sought out or develop over time through social contagion, where individuals become more similar to their friends (Shalizi & Thomas, 2011). Adolescents, in particular, experience high levels of contagion, leading to increased similarity within their social circles (Chierchia, Piera Pi-Sunyer, et al., 2020).

Personality traits, nonverbal expressivity, physical attractiveness, mimicry, and perceived similarity all play significant roles in determining likeability. This similarity effect, whether real or perceived, enhances psychological equilibrium, triggering attraction and strengthening ties (Heider, 1946; Montoya & Horton, 2013). For instance, similarities in music tastes, religion, and ethical views significantly boost the likeability (Launay & Dunbar, 2015). Perceived similarity often has a greater impact on intimacy, conversational satisfaction, and the desire for further interaction than actual similarity (Sprecher, 2014). Having similar likes can be more influential in

determining likeability than similar dislikes (Zorn et al., 2022). Behavioral mimicry, such as copying gestures and postures, enhances likeability, particularly among prosocial individuals (Chierchia & Coricelli, 2015; Stel et al., 2011).

Physical attractiveness remains a significant predictor of being liked across various acquaintance levels (Fultz et al., 2024). Personality traits such as agreeableness, extraversion, and conscientiousness are highly predictive of likeability due to their positive impact on social relationships (Wortman & Wood, 2011). Traits enhancing perceived competence or virtue, such as assertiveness and extraversion, significantly impact likeability (Grosz et al., 2024). While charisma boosts likeability in initial interactions, its effect may diminish over time (Fultz et al., 2024). Long-lasting positive traits include competence, assertiveness, decisiveness, benevolence, trustworthiness, and morality, with communal traits having a stronger relationship with a unique liking in dyadic interactions (Dufner & Krause, 2023).

Adolescents social status depends on their ability to think and act in a prosocial and cooperative manner, with popular adolescents being able to do both whereas rejected ones are not (Pakaslahti et al., 2002). This relationship is unidirectional; while cooperative behavior positively correlates with peer acceptance over time, peer acceptance does not significantly boost cooperative behavior (Chávez et al., 2022). The relationship between cooperative behavior and social status can also be seen through academic success, where both cooperation and sociometric status—an assessment of an individual's peer acceptance, likability, and popularity within a social group—are positively related to academic success (Bahar, 2010; Guo et al., 2018; Soponaru et al., 2014).

Adolescents who engage in prosocial and cooperative activities are more likely to be accepted by their peers, supporting their academic performance. Better academic results are often linked to higher sociometric status—peer acceptance, likability, and popularity—creating a

positive feedback loop that supports academic success. Being liked by peers positively influences self-evaluation (Srivastava & Beer, 2005). Adolescents who are accepted by their peers and have stable friendships are less likely to develop antisocial behaviors and are more likely to interact well in school and future work environments (Marion et al., 2013; S. E. Nelson & Dishion, 2004). This highlights the importance of social strategies during adolescence for successful social reorientation.

In conclusion, the predictors of being liked include a combination of personality traits, nonverbal expressivity, physical attractiveness, mimicry, and perceived similarity. These factors are influenced by social value orientations, shared characteristics, and self-evaluations, providing a comprehensive understanding of likeability in social interactions. Moreover, cooperation plays a critical role, as prosocial and cooperative behaviors enhance peer acceptance and strengthen social bonds, which are essential for successful social integration and overall well-being during adolescence. This raises the expectation that cooperative behavior, even in controlled laboratory settings with anonymous peers, may reflect similar dynamics in real-world contexts, such as being liked by classmates. The current research seeks to explore whether these behaviors observed in experimental settings are predictive of peer acceptance in naturalistic social environments.

## Determinants of Being Disliked

The emotional and behavioral characteristics of adolescents often influence peer relationships. Usually competitive and aggressive traits have been seen to be linked with peer dislike and rejection in children as well as adolescents (Denham et al., 1990; Rubin et al., 2006). However, the exact nature of this relationship remains unclear—whether antisocial behavior leads to peer dislike, whether adolescents act antisocially because they are disliked, or if both factors are at play

Specifically, both direct aggression (the aggressor directly attacks the victim either verbally or physically) and indirect aggression (socially manipulative behaviors where the aggressor attacks the victim indirectly through others) are linked to peer dislike but not necessarily to reduced peer acceptance. This distinction is important because being disliked and not being accepted are not simply opposites. Some characteristics related to competitive behavior, like aggressive behavior, can predict peer dislike without significantly affecting peer acceptance (Keresteš & Milanović, 2006). Being disliked is also positively correlated with both relational and overt aggression, sometimes, more so in boys than girls, and negatively correlated with GPA and prosocial behavior (Gorman et al., 2011). Harming peers' relationships using gossip, manipulation, and exclusion (relational aggression) is strongly correlated with having conflictual friendships with disliked adolescents (Voulgaridou & Kokkinos, 2023). When we dislike someone our perception of them changes as well, they are often seen as less honest, friendly, stable emotionally, and responsible than liked people (Aumer et al., 2015). This could lead to disrespectful behavior toward disliked individuals which in turn makes them aggressive. Peer rejection and disrespect cause significant emotional distress in adolescents, especially those who are prone to perceive rejection as intentional and hostile (Reijntjes et al., 2011). This can manifest as anger and competitive behavior, leading to retaliatory aggression (Yue & Zhang, 2023).

Mutual dislike among peers can create a vicious cycle, increasing feelings of rejection and further hindering social interactions. This dynamic can lead to more significant emotional and social adjustment problems (Betts & Stiller, 2014). An example of this could be being bullied, which is typically done to students with low social standing by aggressors who hold a higher one (Zequinão et al., 2020). Both actors face long-term consequences from being involved in bullying. The effects on victims can include suicidality, pharmaceutical use, psychosomatic problems, and

depression. Whereas the aggressors usually struggle with several externalizing issues, including criminal activity or recurrent aggression in adolescence and adulthood (Kupersmidt & Patterson, 1991). The negative effects of being disliked can have far-reaching consequences. For example, middle-aged people who were rejected by their peers as adolescents and had no friends reported feeling less satisfied with life and having worse relationships (Marion et al., 2013)

In conclusion, the emotional and behavioral traits of adolescents significantly influence their peer relationships, with hostility and aggression often leading to peer rejection. While there is no clear consensus on whether antisocial behavior causes peer dislike or the reverse, both direct and indirect aggression are consistently linked to being disliked. This rejection is particularly pronounced in boys and negatively affects both academic performance and prosocial behavior. Disliked individuals are often viewed negatively, which can lead to disrespect and retaliatory aggression. This cycle of mutual dislike can cause emotional and social adjustment issues, as seen in cases of bullying, which have long-term negative effects on both victims and aggressors.

Overall, the studies above suggest that prosocial/cooperative and aggressive behaviors are among the most well-known predictors of being liked or disliked by daily interaction partners, such as classmates. However, these behaviors have laboratory counterparts—cooperative and competitive behaviors—that may also play a crucial role in understanding peer dynamics. In the following sections, we will illustrate these lab-based behaviors and, returning to the main objective of this dissertation, ask if they correspond to real-world social integration and peer acceptance during adolescence.

## The Role of Peers in Adolescent Social Development

Numerous studies highlight the importance of early social interactions for humans' and animals' behavioral, emotional, and neurological development. Stable friendships during this time

enhance resilience, brain plasticity, and mental health, while social deprivation leads to negative effects such as behavioral issues, elevated stress, and depressive symptoms (Bagwell & Schmidt, 2011). Substantial neurological changes occur during this period, and the presence of dependable, supportive friendships can significantly impact these changes. Stable friendships enhance brain plasticity and improve brain connectivity, which is essential for cognitive and emotional development (Becht et al., 2021). Resilience is greatly increased by stable friendships, as teens with encouraging peers are better at overcoming obstacles and show higher levels of social and emotional resilience, critical for normal growth (Harmelen et al., 2017). Moreover, stable peer interactions are linked to better mental health outcomes, benefiting adolescents' mental health, social skills, and academic achievement (Güroğlu, 2022). These supportive relationships serve as stress reducers, promoting overall well-being and creating an environment conducive to brain growth.

Socialization also plays a significant role in shaping one's identity and guiding behavior in various social contexts. Peer influence positively impacts academic performance, particularly in areas such as writing and math, through the mediating roles of learning motivation and learning engagement (DeLay et al., 2016; Shao et al., 2024). Social networks provide essential emotional support and coping mechanisms, helping individuals navigate and recover from adversities, and fostering a sense of belonging and purpose that is integral to psychological well-being (Masten, 2014). Friendship quality is strongly associated with resilient functioning through constructive coping mechanisms and supportive networks (Graber et al., 2016; Van Harmelen et al., 2017, 2021).

When adolescents don't manage to socialize with their peers successfully, it can lead to negative consequences. Reduced social interaction is positively correlated with lower quality of life, poor self-rated health, extended sitting times, insufficient sleep duration, and depression, particularly in low- to middle-income countries (Luo et al., 2020). This trend is seen in animal studies as well; for example, social deprivation in rats heightens depressive symptoms and diminishes social ties (Gilles & Polston, 2017). Social isolation has been shown to affect brain structure and function, causing aberrant neural architecture, altered neurotransmission, and socioemotional and cognitive deficiencies in multiple animal models (Xiong et al., 2023).

Gender identity is also influenced by social circles, shaping how children and adolescents understand and express their gender. According to identity theory, gender functions as a diffuse status characteristic that is salient in person, role, and social (group) identities across various social situations (Carter, 2014). Additionally, socialization practices in educational and peer environments significantly shape gender norms and expectations, thereby influencing individual gender identities and expressions (Martin & Ruble, 2010). These practices reinforce societal gender roles, affecting personal identity and societal participation in profound ways.

## Adolescent Social Decision-Making

Adolescence is a critical period for developing social decision-making skills, as cognitive, emotional, and social changes during this time greatly influence how adolescents navigate peer relationships. Consider a high school student who must decide whether to join a clique that partakes in risky activities, such as experimenting with drugs or skipping classes. The student must weigh the personal costs of poor academic performance and health issues against the potential

social rewards of acceptance and popularity. These choices require sophisticated social cognition and emotional control—abilities that develop markedly during adolescence (van den Bos, 2013).

## Social Decision-Making Paradigms

A recent approach to social decision making and social interactions is influenced by game theory, neuroeconomics, and computational biology. This approach uses multi-agent decision problems to probe individual differences in social behavior and sensitivity. These paradigms were originally used to study strategic behavior, akin to games in the conventional sense—a competitive activity with a set of rules where a player's decision affects other players' actions and vice versa (Owen, 2013). Researchers study these phenomena by simulating social interactions and decision-making scenarios in a more controlled environment (Kilford et al., 2016; Thielmann et al., 2021). Due to their variability in design and computational and quantitative nature, these paradigms measure diverse concepts such as trust, fairness, cooperation, and altruism. This approach typically trades off ecological validity for experimental control, allowing researchers to isolate and study specific social behaviors in a controlled environment.

An example of game-theoretic paradigms being used to measure social decision-making is the ultimatum game. In this game, one player proposes a way to divide a sum of money, and the second player can either accept or reject the offer. If the offer is rejected, neither player receives anything. This game demonstrates that the understanding of and preference for fairness develop throughout adolescence. Younger children (ages 6-8) are more likely to accept unfair offers than older adolescents (ages 14-15), indicating an increased sensitivity to fairness with age (Marchetti et al., 2019). Additionally, younger participants focused more on the equality of outcomes (egalitarianism), while older participants were more likely to consider the intentions behind the offers (intention-based reciprocity) (Sul et al., 2017). A similar progression is seen in the

development of trust. Younger adolescents were shown to have higher initial trust in the trust game, which could be due to their underdeveloped perspective-taking skills and lack of understanding of the intentions of other people (Sijtsma et al., 2023). As they age and develop, adolescents show a decrease in initial trust but an increase in adaptive trust, so they are more likely to trust others only if they think that the trust will be reciprocated back (Fett et al., 2014; van den Bos et al., 2011). This heightened priority for reciprocal behavior in adolescence was studied further using the dictator game, where mid-adolescents invested more in peers with whom they have better social connections, but late-adolescents only invested in peers with whom they have stronger reciprocal ties (Burnett Heyes et al., 2015). All these results converge into the idea that adolescents become more selective about with who they cooperate and in which situations they do so.

## Cooperative and Competitive Coordination Paradigms

Paradigms that are designed to specifically look at our ability to coordinate with others in cooperative and competitive environments in the face of risk are called coordination games. They are called Coordination Games because success depends on players coordinating their actions with each other without communicating (Camerer, 2003). A classic example of a cooperative coordination game is the "stag hunt". In one version of this game, two players are to simultaneously decide between one of two options: a safe payoff option and a potentially higher-paying but uncertain option. If one of them chooses the safe payoff option (SP), they will receive a payoff no matter what their counterpart chooses. Alternatively, they can choose the uncertain payoff option (UP). In that case, they can get a higher payoff than the SP, but only if their counterpart also chooses this uncertain option as well. If one player selects UP while the other player does not, the former will receive no payoff at all, and the latter will earn the safe payoff. This game is based on

a story by Rousseau in which two hunters must decide whether to hunt a stag together or hunt rabbits individually. Hunting the stag requires both players to cooperate and can yield a larger payoff than what could be obtained individually. If only one of them hunts the stag while the other hunts rabbits, the stag hunter gets nothing, and the rabbit hunter gets a smaller, but certain, reward (Skyrms, 2001). The stag hunt is also known as an "assurance game" because players will choose stag only if they are assured others are likely to choose stag as well, which mainly exemplifies matching behaviors (Jansson & Eriksson, 2015).

On the other hand, there are also coordination games that focus on competition or mismatching, with a prime example being entry games. In entry games, everything is like the Stag Hunt game, but with an important exception: if both players choose UP, they both get nothing. However, if only one player chooses the UP, that player gets a high payoff while the player who decides to choose the SP gets a sure, but lower payoff (Camerer & Lovallo, 1999). This scenario is more competitive because, in contrast to a cooperative coordination game where all players can maximize their payoff simultaneously, here only one player can achieve the highest payoff. Players must mismatch their choices to avoid both getting nothing, similar to avoiding a traffic jam by not all taking the freeway at the same time.

What makes these games especially challenging is the existence of multiple Nash equilibria, which are a set of strategies where no player can benefit by changing their strategy while the other players keep theirs unchanged (Kreps, 1989). For example, in the cooperation game, the Nash equilibrium is achieved when both players either choose SP or UP (Skyrms, 2001). This additional task of choosing an equilibrium that is not only beneficial to them but also to their counterpart is the reason why coordination games are called the hardest problem in game theory (Camerer, 2003).

Strategic reasoning is a crucial aspect of these games, characterized by rationality and common knowledge. Rationality posits that players will make choices that maximize their benefits, considering the information at hand. It's about making decisions that serve their interests best (Levin & Milgrom, n.d.). Common knowledge of rationality (CKR) assumes that all players recognize the rationality of others (De Freitas et al., 2019). This leads to recursive reasoning, where players think about what others are thinking, adding complexity to the game (Halpern & Rêgo, 2009).

Despite these strategic analyses of rules and incentives, decisions are influenced by contextual features, such as the social context. Adolescents' social behavior becomes more strategic relative to child social behavior, as they need to anticipate and respond to the actions of others. One could hypothesize that strategic behavior is associated with social integration in adolescents.

While much of adolescent social decision-making hinges on social factors, non-social cognitive abilities, such as non-verbal reasoning, also play a crucial role in determining behavior in social contexts, including performance in economic games and coordination tasks. These cognitive abilities, especially non-verbal reasoning, are essential for both social integration and strategic performance in games involving cooperation and competition. During adolescence, these abilities improve significantly, alongside the development of other social skills such as trust and reciprocity. Adolescents' tendency to make riskier decisions than adults is linked to the ongoing maturation of their cognitive control and reward-based neural systems (Crockett et al., 2023; Steinberg, 2008).

Research has shown that higher non-verbal reasoning abilities contribute to more consistent and strategic decision-making, while lower abilities may result in more random and less

predictable choices (Amador-Hidalgo et al., 2021; Mechera-Ostrovsky et al., 2022). This link is particularly strong in non-emotional contexts, where executive functioning directly influences decision behaviors (Figner et al., 2009). As adolescents refine these cognitive skills, their ability to navigate complex social interactions improves, influencing their behavior in both cooperative and competitive environments.

In competitive scenarios, like the previously mentioned game, only one player can achieve the highest payoff, requiring players to mismatch their choices to avoid mutual loss. This scenario is more competitive because it contrasts with cooperative coordination games, where all players can maximize their payoff simultaneously. Understanding these dynamics in controlled environments can help illuminate the mechanisms underlying social integration and peer acceptance.

## The Association Between Coordination Abilities and Social Integration

Based on the evidence reviewed, it seems plausible that performance in coordination tasks may be linked to social integration, as these tasks involve adjusting one's behavior based on the anticipated choices of others, making them inherently social. Several studies have examined how social integration influences behavior in these tasks, particularly when comparing interactions with humans versus non-human elements like lotteries, and when considering the impact of perceived similarity and established relationships with counterparts.

Chierchia and colleagues (2018) explored whether individuals behaved differently when engaging with nature (e.g., lotteries) compared to interacting with other participants in cooperative and competitive environments. Their findings revealed that in cooperative settings, participants displayed a greater inclination toward uncertain payoffs (UP) compared to other environments,

suggesting a heightened propensity for risk-taking in cooperation. In contrast, in competitive games, participants exhibited significantly more switching than both cooperative and lottery-based games. This variability, combined with increased reaction times, suggests that participants were more uncertain and strategic in competitive environments, reflecting a need to adjust their behavior based on the anticipated actions of others. Cooperation was unique for its association with risk-taking, while competition was characterized by strategic variability and hesitation.

The study also found that this propensity for cooperation and aversion to competition was amplified when participants interacted with similar counterparts, even when there was no strong personal affinity between them (Chierchia & Coricelli, 2015). This suggests that perceived similarity may enhance predictability, thereby making risk-taking in cooperative settings more appealing. The predictability offered by similarity seems to increase the participants' comfort with uncertainty, leading to greater risk-taking. However, when competing with similar others, participants demonstrated decreased risk-taking, possibly due to recursive reasoning, where overthinking the potential strategies of their counterparts leads to hesitation and indecision.

Building on this, Chierchia and colleagues (2020) investigated how deeper forms of social integration, such as friendship, impact behavior in coordination tasks. They found that friendships significantly influenced both cooperative and competitive behaviors, reducing uncertainty and facilitating more effective coordination. For instance, friends performed better cooperative coordination problems and were less competitive overall. Participants reported that playing with friends altered their decision-making processes, driven by mentalizing and motivational mechanisms like empathy and altruism.

These findings underscore the critical role of social integration in shaping decision-making within coordination games. In cooperative scenarios, stronger social bonds, whether through similarity or friendship, promote a greater acceptance of uncertainty, fostering cooperation and leading to larger payoffs. Conversely, in competitive settings, closer social ties can introduce strategic uncertainty, reflected in increased switching and reaction times, as participants grapple with recursive thinking. By enhancing predictability in cooperative games and complicating decision-making in competitive ones, social integration plays a complex but pivotal role in coordination tasks. While previous research has shown that social integration influences performance in coordination tasks, the reverse relationship remains underexplored. Specifically, it is unclear whether coordination with anonymous interaction partners in cooperative and competitive environments relates to how much individuals are liked or disliked by their peers in everyday life. This raises important questions about whether the ability to effectively coordinate in experimental settings can predict social standing in more naturalistic social contexts.

## Aims

Prior research on coordination games has primarily examined adult populations, focusing on how they discriminate between various contexts and how social closeness affects their behavior. However, this emphasis on adults leaves significant gaps in understanding the development and implications of these behaviors during adolescence. As a preliminary question, this study first asks whether adolescents, like adults, distinguish between cooperative, competitive, and non-social lottery environments, to better understand the nuances of their decision-making processes. The main objective is to examine how coordination strategies in cooperative vs. competitive coordination problems with anonymous others relate to adolescent social integration in their

classrooms, investigating whether adolescents are liked because they can navigate social situations effectively or simply due to their traits, independent of social context.

Research Questions

- Do adolescents differentiate between cooperative, competitive, and lottery decision contexts?
- Does decision-making in these contexts relate to social integration?

Hypotheses

- Hypothesis 1: Adolescents will exhibit different behaviors across cooperative, competitive, and lottery decision contexts, with a greater propensity for cooperation and an aversion to competition.
- Hypothesis 2: Increased risk-taking in cooperative tasks will be associated with higher social integration, while greater risk-taking and decision variance in competitive tasks will be linked to lower social integration.

# Methods

## Participants

N = 177 native Italian-speaking participants (80 girls) were recruited for the study. The participants were between the ages of 10 and 14 years (M = 11.9, SD = 0.98). Each participant spoke Italian as their first language, had normal or corrected to normal eyesight, and was unaware of the study's objectives. They were recruited by submitting a request to the principal of their respective schools. Before the experiment, informed consent was acquired from every

participant. Protocol approval (ethics approval number 113/22) was granted by the University of Pavia's psychological ethical committee, and participants were treated in compliance with the Declaration of Helsinki.

# Materials

## Social Integration

Social integration was assessed using sociometric nominations, a method commonly employed to gauge peer acceptance and rejection within a group. In this study, sociometric data were collected in classrooms by providing each student with a sheet of paper containing six empty lines and printed instructions. Each student was given a sheet and asked to nominate three classmates of either sex whom they liked most (ML) and three classmates whom they liked least (LL) (Coie & Dodge, 1988). To maintain confidentiality, children were instructed to write only the first three letters of their classmates' names and surnames. The collected nominations were then transformed into scores standardized across classrooms, accounting for the varying number of students in different classrooms.

While social integration is a multifaceted concept, in this study, it is operationalized through ML and LL nominations. These nominations serve as direct indicators of peer acceptance and rejection, which are central to understanding an individual's social standing and integration within the classroom environment. By focusing on how well an individual is liked or disliked by their peers, this measure provides a meaningful representation of their social integration.

## Cooperation and Competition

Adolescents were tested in their IT classrooms, each using their own designated device. Upon entering the classroom, participants were assigned to a computer cubicle. They first completed a standard demographic survey and an informed consent form. An experimenter then provided instructions for the procedure using a PowerPoint presentation, introducing the three decision environments: two coordination games and an ambiguous lottery, each described neutrally. Participants learned they would choose between a sure payoff (SP), labeled as a "mini treasure" worth a specific amount of virtual gold coins, and a "super treasure" with a potentially higher but uncertain payoff (UP), worth either 15 or 0 gold coins. If participants chose the SP, they earned that gold amount regardless; choosing the UP had different consequences depending on the game.

The two coordination games were selected from the literature on behavioral game theory. The stag hunt (also known as the assurance game) was chosen as a measure of cooperative behavior (Heinemann et al., 2009) whereas the entry game was chosen for competitive behavior (Camerer & Lovallo, 1999). Based on this, games will be addressed as cooperation and competition games in this paper. The terms "cooperation" and "competition" were never used during the instructions and task, allowing participants to infer the nature of the games based on the incentives alone. The cooperation conditions were indicated by the label "only if both" as well as a corresponding illustration (see Fig. 1). Participants could receive the highest payoff (15) after choosing the UP only if their anonymous counterpart chose this option as well. Thus, both participants maximized their coins by selecting the uncertain option. Conversely, the competition condition was labeled as "only if alone," and had a corresponding illustration as well. Here, one earned the maximum payoff

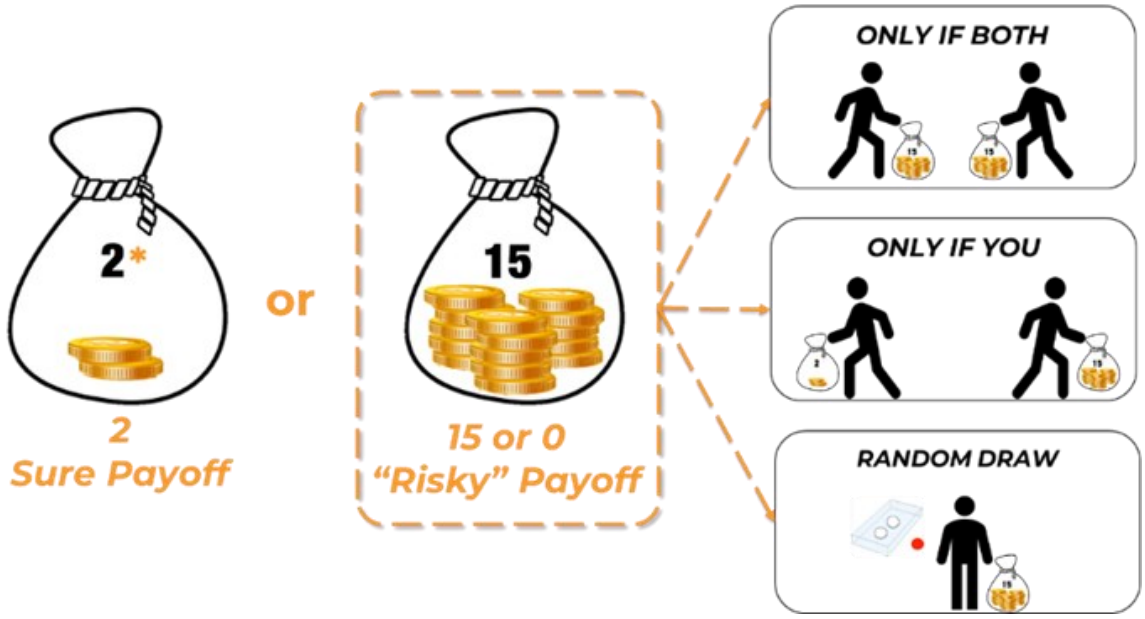
only if they chose the uncertain option and their counterpart did not. If both chose the uncertain option, neither won anything.

The lottery condition was labeled “random draw,” and its illustration was placed above the UP choice to indicate it as the uncertain option. In this condition, the UP resulted in the maximum payoff based on a draw from a random (non-social) lottery. To ensure that the participants understood this condition, their attention was drawn to an empty opaque box into which two blue balls and two red balls were openly placed before closing and shaking it. Two balls were then removed by another experimenter without revealing their colors to anyone, leaving the box with an unknown combination of balls. Participants were informed that a single ball would be drawn by a computer at the end of the session to determine the lottery payoff. Specifically, the UP would be won only if a red ball was drawn, and since the remaining balls' colors were unknown, the probability of drawing a red ball was also unknown. This setup mirrored the uncertainty in coordination games, where the probability of others choosing the SP or UP is unknown. This condition was used as a control for non-social factors.

All three games (lottery, cooperation, and competition) consisted of 15 trials each, for which participants did not receive any real monetary compensation. The purpose of the games was to observe the players' social decision-making rather than learning or belief updating. Therefore, no feedback revealing the outcome of the choices was provided after each trial to prevent such effects. The order of the three games was randomized for each participant (e.g., one participant might start with the lottery, another with cooperation). All games were played in a single session and in blocks to minimize confusion from task switching. The experiment was implemented using the Gorilla Experiment Builder (www.gorilla.sc) (Anwyl-Irvine et al., 2020). The three games and their choices are illustrated in Figure 1.

Figure 1.

Summarized representation of coordination and lottery games




Note: Coordination (cooperation or "only if both" and competition or "only if you") and the random lottery (random draw). Participants could choose between a sure payoff and an uncertain payoff, whose choice outcome depended on the condition, similar to Chierchia et al. (2018). The illustrations on the right are used to both identify the condition the participant was playing in and the UP choice between the two (placed above the bag) *The SP value pseudo-randomly varied between 1 and 15.

The order of tasks was consistent for all participants: starting with the pre-coordination questionnaire, followed by the coordination games and lottery (in randomized blocks), then the post-coordination questionnaire, and finally the MaRs. The entire experiment lasted between 30 and 40 minutes.

## Matrix Reasoning (MaRs)

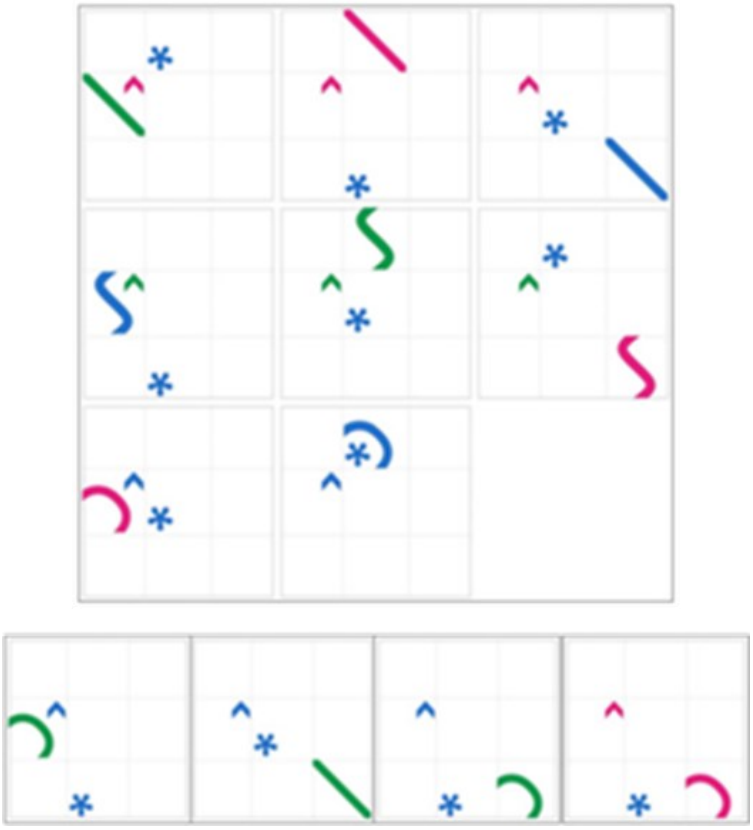
The Matrix Reasoning Item Bank (MaRs-IB) (Chierchia et al., 2019) is an open-access, non-verbal abstract reasoning task featuring incomplete matrices containing abstract shapes (Figure 2). Similar to Raven's Progressive Matrices (Raven & Raven, 2003), participants in the MaRs-IB are required to recognize the relationship between matrices at varying levels of complexity and choose the correct missing square among four options for 16 trials. The items consist of a three-by-three matrix containing abstract shapes in eight out of nine cells. Participants deduce relationships across the eight shapes, which could vary across four relations: color, size, position, and shape. No feedback is provided regarding the accuracy of their choices, and participants are asked to complete each "puzzle" as quickly and accurately as possible. They have 30 seconds to complete each matrix, with a 5-second countdown alerting them when the task is about to proceed to the next picture if they are indecisive. The Matrix Reasoning Item Bank (MaRs-IB) is a reliable and valid measure of abstract reasoning. It has demonstrated good split-half and test-retest reliability, indicating that the test produces stable and consistent results when administered multiple times under the same conditions(Zorowitz et al., 2023). In terms of validity, the MaRs-IB has shown satisfactory convergent validity and has also been psychometrically validated within an item response theory framework. It was found that participants' ability to solve MaRs-IB puzzles was moderately predictive of their performance on a working memory task and the ICAR matrix reasoning test (Chierchia et al., 2019). Based on this work, we used optimal test assembly to select a set of MaRs items optimized for distinguishing between typically observed adolescent performance levels.

Regarding the way performance was measured, focus was given to the mean number of correct

answers across 16 trials, as all participants had a fixed time limit for each trial. Greater MaRs scores are interpreted as higher non-verbal reasoning abilities.

Figure 2.

Example of an Incomplete MaRs Matrix



Note: this matrix is to be completed by selecting one of the four options below. Participants infer patterns of shapes and colors within each square. The correct answer is the third option from the left. Reprinted from Chierchia et al. (2019).

## Statistical Analysis

The three independent variables of this study were Risk (frequency of UP choices), Switching, and Response Times (RT). These measures are crucial for distinguishing between cooperation and competition, thereby exploring strategic ability. Uncertain choices were coded as 1 if participants chose the uncertain option (UP), and 0 if they chose the safe option (SP).

Switching was constructed similarly to Chierchia et al. (2020). For each game, the 15 trials were ordered in ascending SP value. Each trial, excluding the first, was coded as "1" if the choice differed from the previous trial and "0" if it remained the same. Switching represents the number of transitions between UP and SP across 15 trials per game, reflecting uncertainty or noise/randomness, or, in competition, strategic reasoning (Chierchia et al., 2018).

Response Time (RT) measures the duration it takes for a participant to make a choice. Similar to switching, RT can indicate uncertainty or lesser understanding and greater impulsivity if low. In competition, increased RTs may suggest recursive reasoning (Chierchia et al., 2018).

To examine whether adolescents behaviorally distinguished between coordinating with their peers versus betting on a random lottery, we first calculated difference scores for each variable of interest (risk, switching, and response times). These difference scores were generated by subtracting the lottery variable from the corresponding variable in the two coordination games (i.e., cooperation and competition), resulting in six difference scores (2 games * 3 variables).

Next, we conducted a one-sample t-test against zero for each of these difference scores. This approach allows us to assess whether there is a significant difference between the mean scores in the coordination games and the lottery condition. Positive scores in the t-test indicate

that the scores in the coordination games (cooperation or competition) are higher than those in the lottery condition.

Three models predicted the number of nominations based on the nomination type (a 2-level factor: most liked vs. disliked) and various aspects of competition and cooperation (modeled as two continuous predictors), along with their interactions with the nomination type. The first model considered the amount of risk-taking, the second model focused on the amount of switching, and the third model examined reaction times.

Additionally, non-verbal reasoning was included in the model and allowed to interact with the type of nomination. This allowed determining if the associations between social integration and decision variables persisted beyond individual differences in non-verbal reasoning and/or if that association depended on non-verbal reasoning ability.

Non-significant omnibus terms were progressively removed, and nested models were compared using likelihood ratio tests to achieve more parsimonious models. We reported the omnibus effects of the most parsimonious models, with significant effects followed up with planned contrasts or trend analyses using the emmeans function from the eponymous package (Lenth, 2023).

The assumption of independent observations was violated because each participant appeared twice (once for the most liked nominations and once for the least liked nominations). Mixed models failed to converge, likely due to a singular fit, and the variance explained by the random intercepts was zero, indicating minimal random effects. Since the results of the mixed

models were nearly identical to those of the multiple regression, we opted to retain the simpler regression approach. All analyses were conducted in the R environment (RStudio Team, 2020).

# Results

## Coordination

Table 1.

Descriptive statistics for Risk, Switching, and Reaction Time across both Coordination and Competition conditions

| | Risk | | Switch | | Reaction Time | |
|---|---|---|---|---|---|---|
| | Cooperation | Competition | Cooperation | Competition | Cooperation | Competition |
| Mean | 0.50 | 0.41 | 0.28 | 0.36 | 2153 | 2364 |
| SD | 0.23 | 0.19 | 0.20 | 0.19 | 1038.91 | 1167.37 |

The mean for Risk is notably higher in the cooperation condition, suggesting a propensity for cooperation. In contrast, both Switching Behavior and Reaction Time have higher means in the competition condition, hinting at an aversion to competition. To further explore and support these observations, t-tests were conducted, which are discussed in the following section.

One-sample t-tests against 0 revealed significant differences in risk-taking, switching behavior, and reaction times across game environments. Risk-taking was higher in cooperation relative to the lottery scenario, with a percentage difference of 0.07 (95% CI [0.04, 0.10], $t(176) = 4.71$, $p < .001$, $d = 0.354$), corresponding to a small-to-medium effect size. Risk-taking was also

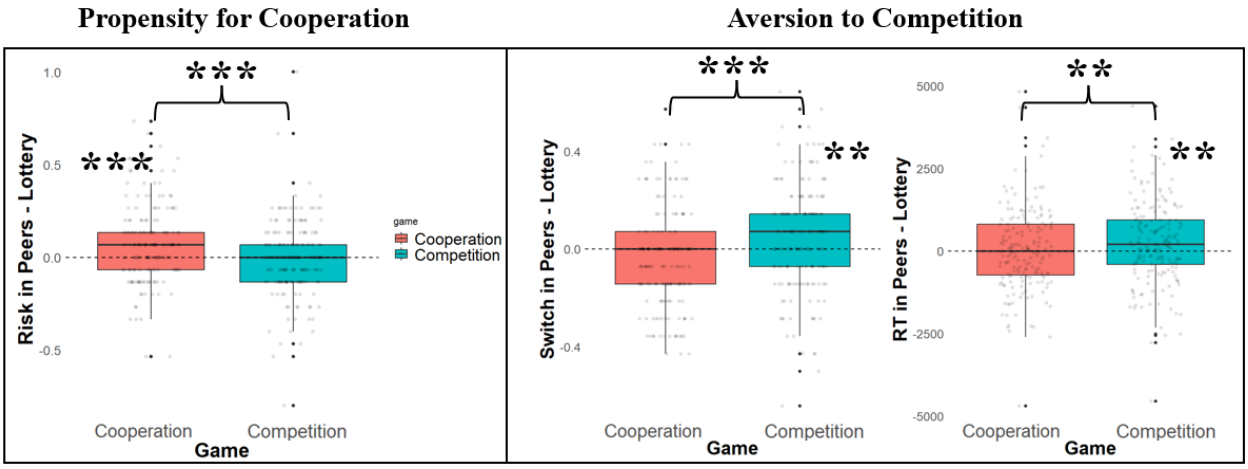
significantly higher in cooperation than in competition, with a percentage difference of 0.08 (95% CI [0.04, 0.12], $t(176) = 4.15$, $p < .001$, $d = 0.31$), indicating a small-to-medium effect size (see Figure 3). These results indicate a clear propensity for cooperation, as adolescents were more inclined to take risks when cooperating compared to a random lottery or a competitive environment.

The results also showed significant differences in switching behavior across game environments. Additionally, switching behavior was significantly more frequent in competition compared to the lottery, with a mean difference of 0.042 (95% CI [0.010, 0.073], $t(176) = 2.603$, $p = 0.010$, $d = 0.196$), indicating a small effect size. Additionally, switching was more frequent in competition than in cooperation, with a mean difference of -0.078 (95% CI [-0.111, -0.046], $t(176) = -4.749$, $p < .001$, $d = -0.357$), indicating a small-to-medium effect size (see Figure 3). A higher frequency of switching in competition suggests greater uncertainty and indecision in these tasks. This supports the notion of an aversion to competition, as participants were more likely to change their decisions under competitive pressure.

Reaction time (RT) analysis revealed significant differences as well. Interestingly, RT in competition was significantly slower than in the lottery, with a mean difference of 242.975 (95% CI [57.273, 428.677], $t(176) = 2.582$, $p = 0.011$, $d = 0.194$), indicating a small effect size. RT was significantly faster in cooperation than in competition, with a mean difference of -211.555 (95% CI [-395.141, -27.969], $t(176) = -2.274$, $p = 0.024$, $d = -0.171$). These results suggest that participants found competition more challenging or stressful, as evidenced by the increased reaction time, further supporting the notion of an aversion to competition.

Figure 3

Differences in Risk-Taking, Switching Behavior, and Reaction Time Between Peers and Lottery Conditions for Cooperation and Competition Games.




Note: The panel for Propensity for Cooperation depicts the difference in risk-taking scores (UP in Peers - Lottery). The horizontal dashed line at y = 0 indicates no difference between the coordination games and the lottery condition. The cooperation condition shows significantly higher risk-taking compared to both the lottery and competition conditions, as indicated by the asterisks and the horizontal bracket marking the significant difference.

The Panel for Aversion to Competition presents two boxplots: one for Switching behavior (Switch in Peers - Lottery) and another for Reaction Time (RT in Peers - Lottery). The switching behavior plot shows significantly higher switching in the competition condition compared to both cooperation and lottery conditions, suggesting increased uncertainty in competition. The reaction time plot reveals that participants responded significantly slower in the competition condition than the lottery, further supporting the aversion to competition.

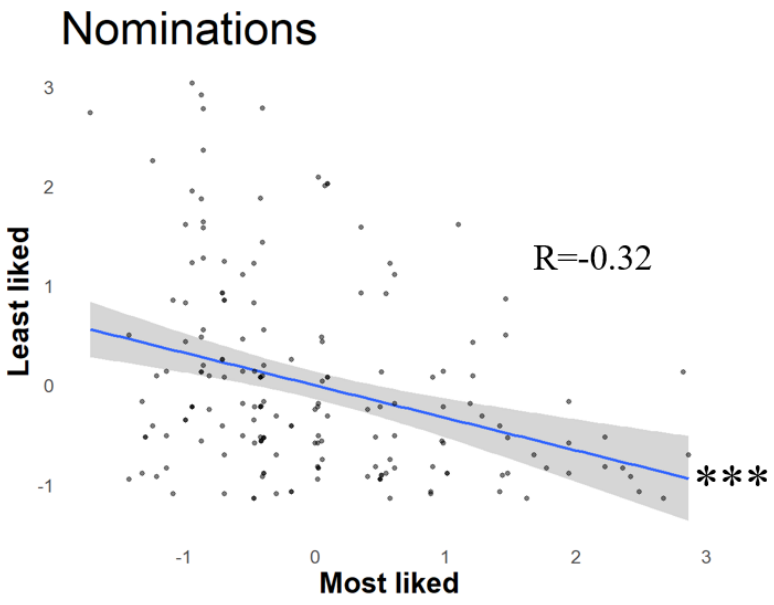
Asterisks (*) indicate the level of statistical significance: ***p < .001, **p < .01. The horizontal brackets highlight significant differences between the Cooperation and Competition conditions for each measure.

## Social Integration Measures

Descriptive statistics for the most liked (ML) and least liked (LL) variables revealed near-zero means (M = 0.00) and identical standard deviations (SD = 0.98) for both measures. Despite this, Pearson product-moment correlation analysis was conducted to assess the relationship between most liked and least liked, which are measures of social integration. The analysis revealed a significant, weak-to-moderate, anti-correlation. Specifically, the correlation coefficient was r = -0.327, p < .001 (see Figure 4). This suggests that, whilst ML and LL are inversely related, they are far from being perfectly anti-correlated and likely measure different aspects of social integration.

Figure 4

Inverse Relationship Between Most Liked and Least Liked Peer Nominations



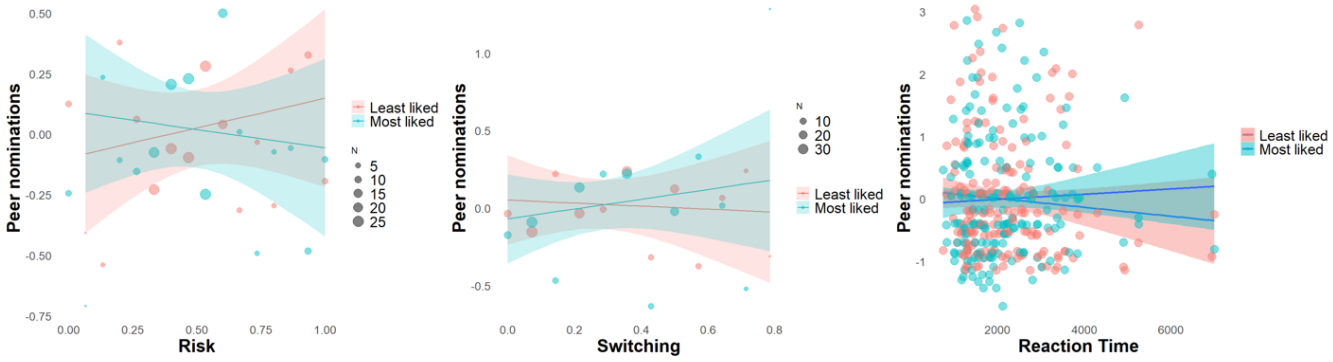
Note: Scatter plot illustrating the relationship between Most Liked (ML) and Least Liked (LL), measures of social integration. Individual data points are plotted with ML scores on the x-axis and LL scores on the y-axis. A negative linear trend indicates an inverse relationship between ML and LL. The Pearson correlation coefficient is $r = -0.327$, $p < .001$. This significant anti-correlation suggests that while higher ML scores are associated with lower LL scores, the relationship is not perfect, indicating that ML and LL likely measure different aspects of social integration.

## Cooperation

In the context of cooperation, the analyses for risk-taking, switching, and reaction time revealed patterns that mirrored those observed in the competitive context; however, none of the interactions or main effects reached statistical significance. For risk-taking, the interaction with the type of nomination on the number of nominations followed a similar pattern to that seen in competition, with risk-taking associated with more least liked nominations, but the interaction was not significant, $F(1, 294) = 0.70$, $p = .404$, $\eta_p^2 = .0015$. Similarly, switching behavior in cooperation also followed the pattern seen in competition, where switching tended to decrease least-liked nominations and increase most-liked nominations, but again, the interaction did not reach significance, $F(1, 294) = 0.46$, $p = .500$, $\eta_p^2 < .001$. Lastly, reaction time in cooperation displayed a similar trend to its competitive counterpart, with no significant interaction with the type of nomination, $F(1, 294) = 0.003$, $p = .954$, $\eta_p^2 < .001$, and non-significant slopes for both least liked ($p = .663$) and most liked nominations ($p = .723$) (see Figure 6). Despite these similar patterns, none of the effects in the cooperative context were statistically significant, suggesting that while cooperative behaviors might follow similar trends as competitive behaviors, their influence on peer nominations does not reach statistical significance.

Figure 5

Peer Nominations as a Function of Cooperative Risk-Taking, Switching, and Reaction Time




The scatter plot shows the interaction between cooperative risk-taking, switching, rt, and peer nominations. The size of each point indicates the number of observations (N = 10, 20, 30), and the shaded areas represent the 95% confidence intervals.

Asterisks (*) indicate the level of statistical significance: ***p < .001, **p < .01. The vertical brackets highlight significant differences between Most Liked and Least Liked nominations for each measure.

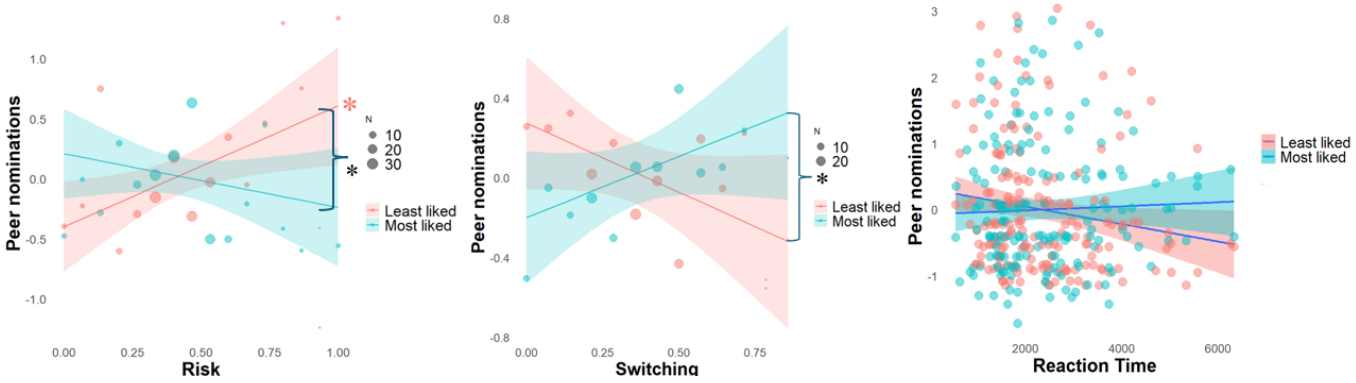
## Competition

Multiple regression analyses revealed significant interactions between competitive behaviors (risk-taking and switching) and the type of nomination on the number of nominations. For competitive risk-taking, there was a significant interaction with the type of nomination, $F(1, 294) = 5.91$, $p = .013$, $\eta_p^2 = .02$, driven by an increase in the least liked nominations (slope = 1.006, 95% CI [0.20, 1.81], $p = .015$). Similarly, a significant interaction was found between switching in competition and the type of nomination, $F(1, 294) = 5.82$, $p = .016$, $\eta_p^2 = .01$, which

was driven by a significant difference between the trends for least liked and most liked nominations (contrast estimate = -1.31, 95% CI [-2.47, -0.15], p = .027). While the interaction between reaction time in competition and the type of nomination did not reach statistical significance, F(1, 290) = 1.20, p = .274, the pattern of results was similar to that observed for switching, with reaction time showing a non-significant trend toward decreasing least liked nominations and increasing most liked nominations (see Figure 5). These results suggest that competitive behaviors, whether in risk-taking or switching contexts, notably influence peer nominations, particularly in being least liked by classmates, and that similar patterns may exist for reaction time.

Figure 6

Peer Nominations as a Function of Competitive Risk-Taking, Switching, and Reaction Time




The scatter plot shows the interaction between competitive risk-taking, switching, rt, and peer nominations. The size of each point indicates the number of observations (N = 10, 20, 30), and the shaded areas represent the 95% confidence intervals.

Asterisks (*) indicate the level of statistical significance: ***p < .001, **p < .01. The vertical brackets highlight significant differences between Most Liked and Least Liked nominations for each measure.

# Discussion

In this study, we investigated how adolescents differentiate between cooperative, competitive, and lottery-based decision contexts and how these behaviors relate to social integration within their peer groups. Our key finding is that competitive coordination behavior, particularly risk-taking and switching, is significantly associated with being more disliked by classmates. This suggests that competitive behaviors might be perceived negatively by peers, leading to lower social integration.

Adolescents, much like adults, demonstrate a propensity for cooperation and an aversion to competition (Chierchia & Coricelli, 2015). This supports previous research and adds new evidence for understanding how these behaviors relate to peer relationships. Notably, while competitive behavior was associated with being least liked, no significant association was found between competitive behavior and being most liked, though the trend was in the expected negative direction. Similarly, cooperative behavior was not significantly associated with social integration, contrary to our hypothesis. These findings highlight the nuanced nature of social decision-making and peer dynamics in adolescence.

The association between competitive coordination behavior and being least liked aligns with our hypothesis that adolescents who engage in riskier or more unpredictable behaviors in competitive settings may be perceived negatively by their peers. This could be due to a reluctance or inability to navigate situations where individual interests conflict with the collective interests of the group. In competitive environments, adolescents may appear self-serving, which could alienate them from peers who value collaboration and prosocial behavior (Nowakowska, 2023).

In competitive contexts, increased variability arises, in part, because competitors are constantly trying to outmaneuver one another, often using recursive reasoning—anticipating how others will act and then adjusting their strategies accordingly. This dynamic creates a feedback loop where each participant's behavior is continually influenced by the perceived or actual actions of their opponents. In competition, this higher variance in behavior—where everyone is trying to do the opposite of one another—may help detect associations more effectively, as the differences in behavior become more pronounced. Conversely, in cooperative environments, the opposite occurs. Everyone is generally working towards the same goal, aligning their actions to achieve mutual success (Nishi et al., 2016; Savikhin & Sheremeta, 2013). This alignment leads to a narrower range of behaviors, effectively closing the observations into a smaller range. As a result, it may be harder to detect significant associations in cooperative contexts because the reduced variability masks any potential patterns.

Additionally, in cooperation, risk-taking may stem from two processes: a motivation to behave prosocially (Liu et al., 2023) and a belief that the other person will also take the risk (Nowakowska, 2023). In cooperative environments (but not in competitive ones), these processes both promote risk choices, potentially diluting the effect of any individual variance. In contrast, competition involves opposing motivations, where those who risk more might not be liked as much, as observed in our findings related to social integration. In competition, if participants perceive others as being more prosocial or "nice," it doesn't necessarily reduce their willingness to take risks. Instead, in competitive contexts, risking less could be interpreted as a sign of one's underlying motivation rather than just a strategic decision based on beliefs about others' actions. Meanwhile, in cooperative contexts, individuals' beliefs about others' actions might overshadow their prosocial motivations, leading to reduced risk-taking.

It's also worth noting that the lack of a significant association between competitive behavior and being most liked may suggest a power issue in our study. Although the relationship was in the expected negative direction, we may have been underpowered to detect a stronger connection. This indicates the need for further investigation with a larger sample size to clarify the nature of this relationship.

Contrary to our expectations, cooperative behavior did not show a significant association with social integration. One possible explanation for this null finding is the reduced behavioral variability in cooperative settings. In competitive environments, where participants must outmaneuver one another, behavior tends to be more variable, which makes it easier to detect patterns or associations (Konings & Hettinga, 2018; Wang et al., 2018). In cooperative contexts, however, individuals tend to align their actions towards shared goals, reducing the range of behaviors and making it harder to identify meaningful associations with social integration.

Moreover, the weak anti-correlation between being most liked and least liked suggests that these two aspects of social integration are not merely opposites but are influenced by different factors. This divergence may explain why cooperative behavior, which fosters prosociality, did not emerge as a predictor of social standing. Cooperation may be a baseline expectation in peer groups, and only deviations from this norm (e.g., competitive behaviors) are salient enough to impact social standing.

The weak anti-correlation between most liked and least liked nominations highlights the complexity of social integration. These two aspects of social standing are not simply opposite ends of a spectrum, but rather distinct phenomena influenced by different behavioral and contextual factors. Loss aversion literature suggests that negative experiences, such as being disliked, may have a stronger impact than positive experiences, like being liked (Asgarova et al., 2020; Diener

& Emmons, 1984). This asymmetry might extend to peer nominations, where the factors that lead to being least liked are not necessarily the same as those that lead to being most liked.

This complexity further explains why competitive behavior is more strongly associated with being least liked. In competitive settings, risk-taking or unpredictable behavior might be interpreted negatively, leading to social penalties, while prosocial behavior in cooperative settings may not be enough to elevate an individual's social standing.

One important limitation of this study is the issue of correlation versus causation. While we observed correlations between competitive behaviors and social integration, we cannot definitively conclude whether these behaviors lead to changes in social standing or whether an individual's existing social standing influences their behavior in competitive contexts (Anderson & Geras, 2022). Future research using longitudinal designs would be valuable in exploring these relationships more deeply, allowing us to uncover the causal mechanisms underlying the link between behavior and social integration (Hall et al., 2021).

# Conclusion and Future Directions

This study contributes to understanding adolescent social dynamics by examining the role of social decision-making in different contexts—specifically cooperation, competition, and lotteries—and how these behaviors relate to adolescents' social integration in the classroom. Our findings show that competitive risk-taking is associated with being least liked by classmates, suggesting that such behaviors may have negative social consequences in peer settings. These results underscore the importance of context in adolescent social interactions, particularly the impact of behavior in competitive environments on peer relationships.

In conclusion, this work bridges the literature on social development and behavioral game theory by providing a nuanced perspective on the potential social costs associated with competitive behaviors. Future research should explore these dynamics further, particularly focusing on the underlying cognitive and social mechanisms that drive these associations and how they may evolve during development. Longitudinal studies could be valuable in disentangling the causal relationships between social behaviors and peer integration, ultimately contributing to more effective interventions promoting positive adolescent social development.

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