Group decision-making on risky choice in adolescents and young adults

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Abstract
Adolescence, a period during which risk-taking behaviors frequently occur, is susceptible to peer influence. However, the direction of peer influence on group decision-making among adolescents and whether it increases group decision-making risk-seeking or risk-aversion is still unclear. This study recruited 84 adolescents (age = 14.44, 48 girls) and 99 young adults (M_{age} = 20.48, 48 women) and adopted two framing tasks (life and money problems) to examine the differences between individual decision-making and group decision-making (of three members each), as well as the strategies for reaching consensus in group discussion. Results showed no evidence that adolescents are more risk seeking than adults in individual decision-making, and the adolescents were even more risk averse toward money problems than adults. We also found that the adolescents were more risk seeking for life problems but more risk averse for money problems in group decision-making than in individual decision-making under the loss frame. Further analysis of group discussion showed that the adolescents were more likely to apply the strategy of “one person puts forward an idea and then the others follow” to reach an agreement, while the adults tended to vote. This study indicated that peers’ influence on group decision-making is domain specific, especially among adolescents.

Keywords Risky decision-making · Adolescents · Group decision-making · Peer

Introduction
Adolescence, a phase of turbulent physical and mental development, is often considered a period of risk seeking (Defoe et al., 2015). Adolescents tend to be involved in substance seeking, reckless driving, delinquency, and other risky behaviors (Willoughby, Heffer, Good, et al., 2021). However, Willoughby, Heffer, Good et al. (2021) claimed that early adulthood is a period of more risk-seeking. Therefore, it is still unclear whether adolescents are more risk seeking than young adults (Kray et al., 2021). Moreover, adolescents tend to have a strong sense of belonging to peer groups (Blakemore, 2018). Therefore, they are more easily influenced by peers. However, previous studies have mainly focused on how the presence of peers increases the risk-seeking propensity of adolescents in decision-making (Haller et al., 2018; Zhang & Zhu, 2021). Few studies have explored the outcomes and processes of group decision-making among adolescents (Haller et al., 2018). This study aims to expand our understanding of when adolescents are subject to peer influence in group decision-making contexts, compared with young adults.

Risky decision-making in adolescents
Previous studies on age differences in risk-taking behavior have not yielded consistent findings. A recent study recruited 5404 participants aged 10 to 30 from eleven countries and found that risky behaviors increased throughout the entire adolescence period and then declined when the individuals entered their 20s, peaking in late adolescence (Steinberg et al., 2018). A meta-analysis conducted by Defoe and colleagues (2015) also found that teenagers are more risk seeking than adults. However, some studies have not found age differences in risk tolerance when making decisions individually (Braams et al., 2019), whereas others even...
found that adolescents are more averse to risks with clearly defined probabilities (Tymula et al., 2012). The inconsistent results of previous studies may be due to the differences in measurement index and task setting. For example, sensation seeking, as indexed by different tasks, such as risky driving on the Stoplight game or approach behavior on the Iowa Gambling Task, peaks at different ages (Steinberg et al., 2014). Additionally, adolescents are more risk averse than adults when outcome probabilities are ambiguous, while they generally make more risky choices than adults when outcomes are certain (Tymula et al., 2012), suggesting that task setting also affects performance across age differences. Willoughby, Heffer, Good et al. (2021) found that early adulthood, rather than adolescence, might be the period of “high” risk-seeking in general and pointed out that future research should answer the question of “how different types of risky behaviors change at different ages and historical periods”. Therefore, based on these inconsistent findings from previous studies, it is necessary to explore whether adolescents are more risk seeking than young adults and the potential causes of these risky behaviors (Kray et al., 2021).

Previous theories explain and predict the development trend of risky decision-making and behavior at the individual level. Neurodevelopmental imbalance models (Somerville & Casey, 2010) hold that there is a potential imbalance between the cognitive control areas and emotional areas of the cerebral cortex during adolescence. Developmental studies have shown that cognitive control abilities steadily improve from infancy to adulthood (Somerville & Casey, 2010). Cognitive control is often significantly weakened in environments involving emotional interaction (Somerville & Casey, 2010). This decline in control is particularly pronounced during adolescence. Due to the high responsiveness of reward-related areas and the immaturity of the prefrontal cortex related to cognitive control in adolescents, this theory predicts that risky behaviors peak in middle and late adolescence at approximately the age of 14–16 (Somerville & Casey, 2010; Rosenbaum & Hartley, 2019). This study therefore further explored the age difference in risky decision-making and predicted that: adolescents are more inclined to make risky decisions than adults (Hypothesis 1).

**Group decision-making vs. individual decision-making**

The risk appetite shown by adolescents may vary with social context (Smith et al., 2014; Blankenstein et al., 2021). Puberty (11–18 years old) is not an overall “highly” risk-seeking period (Willoughby, Heffer, Good, et al., 2021). Adolescent risky decision-making may mainly occur in social contexts that include peers (Smith et al., 2014; Zhang & Zhu, 2021). Compared with other life cycles, the obvious feature of adolescence is its susceptibility to the influence of peers (Blakemore, 2018). Adolescents are very sensitive to social exclusion and social rewards, hope to be accepted by peer groups, and have a strong sense of belonging to peer groups (Blakemore, 2018). These may lead them to conform to peers. However, previous studies have mainly explored the impact of peer presence on adolescent risky decision-making (Haller et al., 2018; Zhang & Zhu, 2021). Few studies have explored the outcomes and processes of group decision-making among adolescents (Haller et al., 2018). Most decisions in real life are made by groups rather than individuals (Koriat, 2015), and thus, the differences between group decision-making and individual decision-making and the process of reaching consensus are extremely important issues (Haller et al., 2018). However, most studies on risky decision-making have been conducted at the individual level (Milch et al., 2009). There are many inconsistent results regarding whether group decision-making is more risk seeking or more risk averse than individual decision-making (Sutter, 2009). In particular, many studies related to the peer effect found that peers could influence adolescents’ risky decision-making in situations such as driving in simulated real environments. However, it is unclear whether the peer effect can be extended to other decision-making situations that rely more on clear deliberation and reasoning (Somerville et al., 2019).

Studies on group decision-making are mainly carried out with adults, and the results regarding the nature or quality of group decision-making and individual decision-making are not consistent. Some studies have found that group decision-making is riskier than individual decision-making. For example, in Sutter (2009), two groups of participants (64 participants in the individual condition and 28 three-person groups in the group condition) completed an investment task (each round of investment has a 1/3 probability of obtaining a return of 2.5 times the invested amount X and a 2/3 probability of losing the invested amount X). The results showed that the investment amount was significantly higher in groups than in the individual condition, which indicated that groups were more risk seeking. Bougheas et al. (2013) manipulated three decision-making conditions: individual decision-making, group decision-making, and individual decision-making after communicating with each other. The results also showed that the groups were more risk seeking than the individuals, which was consistent with the results of Sutter (2009). However, some studies have found conflicting results. Masclot et al. (2009) found that in lotteries with two options (one is a relatively safe option with low risk, and the other is a risky option with high risk and high return), groups are more likely than individuals to choose the safe lottery.
Therefore, this study investigated the differences between group and individual decision-making of adolescents and adults. Extant theories predict and explain differences between individual and group decisions. The social deliberation effect claims that group discussions can promote deliberation and analytical reasoning processes, allow participants to spend more time providing and listening to more arguments, combine their views, and share resources to make decisions (Keshmirian et al., 2022). Combined with the findings of Olschewski and Rieskamp (2021) on adults, which showed that a lack of deliberation may lead to more risky decisions, and the influence of peers on adolescent risk decision-making described above, the following hypothesis is proposed: the group decision-making of adolescents is more risk seeking than individual decision-making, while that of adults is more risk averse than individual decision-making (Hypothesis 2).

The difference between group and individual decision-making may be moderated by other factors, such as frame type and decision context. Cheng and Chiou (2008) used two frames of gain and loss to investigate the performance of participants in individual decision-making and group decision-making. Group decision-making was tested one week after individual decision-making, and they found that under the gain frame, the group was more risk averse than the individual, and that in the loss frame, the group was more risk seeking, which enhanced the framing effect, indicating that the group was more irrational. Milch et al. (2009) used two tasks related to life and money and manipulated the composition of the group with or without prior decision-making experience. They found that there was no significant difference between group and individual decision-making for life-related risk choices. For intertemporal decision-making tasks in terms of money, the difference between group decision-making with no previous experience and individual decision-making showed the opposite pattern.

The inconsistent results may also be due to differences in task difficulty, such as the classic framing task or more complex variations in the framing task. Chierchia et al. (2020) suggested that this manipulation might add extra working memory burden and then affect participants’ performances. In this study, we adopted the classic framing tasks widely used in risk decision-making studies (e.g., Wang, 1996; Mandel & Kapler, 2018; Tombu & Mandel, 2015) to examine age differences. Each problem in the framing task has two options to choose from: one is a certain option (e.g., 200 people will be saved), and the other is an uncertain option with risks (e.g., there is a 1/3 chance that 600 people will be saved and a 2/3 chance that no one will be saved). This task measures not only individuals’ risk preferences but also how dependent that preference is on the way options are described (when the problem is described in the form of a positive or gain frame, people tend to choose certain options, while they tend to choose risky options when the same problem is described in a negative or loss way). Second, as mentioned above, the task domain is another factor that leads to confounding results (Milch et al., 2009; Wollowby, Heffer, Good, et al., 2021). Previous studies have found that people’s risk-taking tendencies vary in the face of life and money problems (Vartanian et al., 2011; Wang, 1996). Wang (1996) found that compared with the money problems, more adult participants tended to take risks when faced with life problems. In contrast, Vartanian et al. (2011) obtained the opposite results. Moreover, all of the above are from studies of adults and thus cannot be directly plied to adolescents. Overall, this study also investigated whether individual and group decision-making differ across task domains. Based on previous research results and taking into account the recent threat of the COVID-19 pandemic to human life and health, we hypothesized that individual decision-making and group decision-making differ across task domains. Especially when facing life problems, both individual and group decision-making may be more risk averse than that when facing money problems (Hypothesis 3).

The current research

The purpose of this research is to explore how adolescents and adults make decisions individually and in group across tasks in risky situations. Specifically, the following research hypotheses are examined: (1) Adolescents are more inclined to make risky decisions than adults; (2) adolescents are more risk seeking in group decision-making than in individual decision-making; and (3) individual and group decision-making differ across task domains, and when facing life problems, individuals are especially more risk averse than when facing money problems. Group discussion process of the participants was recorded for content analysis to obtain more valuable information about whether adolescents and adults use different strategies in groups to reach agreements.

The current research
Methods

Participants

A total of 87 adolescents aged 13–16 years (M\text{age} = 14.41, SD = 0.58; 48 girls) and 99 adults aged 18–26 years (M\text{age} = 20.48, SD = 1.64; 48 girls) participated in this study. Three adolescent participants were excluded from later data analysis due to their withdrawal from the experiment. There were 33 adult groups and 28 youth groups with three participants of the same age and sex in each group. The participants in each group were friends in daily life. Most of the adult participants were recruited online from universities in Beijing, Shandong and Anhui Provinces. The young participants were from a junior high school in Shandong Province. Informed consent was obtained from each participant. This research was approved by the Institutional Review Board (IRB) of our Institute.

Design and material

This study utilized a 2 age groups (between-subjects factor: adults vs. adolescents) * 2 decision-making conditions (within-subjects factor: individual vs. group) * 2 task domains (within-subjects factor: life vs. money) * 2 frame types (within-subjects factor: gain or positive frame vs. loss or negative frame) mixed experimental design. The dependent variable was the participant’s response to each question. Two types of framing tasks were used in this study: one was framed in the life domain, and the other was framed in a money domain. Each contained two questions, a gain (or positive) frame problem and a loss (or negative) frame problem. The frame type used a within-subjects design for each task, and two decision-making problems were used in each task (i.e., life task or money task).

Specifically, the classic Asian disease problem (“A country is preparing to tackle a rare Asian disease that is expected to kill 600 people”) and the parallel lung cancer problem (“A National Cancer Institute of a country proposes two lung cancer treatment regimens that may become the national standard of care”) were used in the life-domain task (see Mahoney et al., 2011; they used Asian disease and lung cancer as parallel tasks in their research). The two monetary tasks were adopted from the experimental materials used in previous studies (Mandel & Kapler, 2018; Tombu & Mandel, 2015), revised for adolescents and adults (The two age groups: “Imagine your $600 worth of investment is about to fail, and if you do nothing, you will lose all your money.” Adults: “Imagine you sign a one-year apartment contract. Something unexpected happened, you can’t fulfill your contract. If you do nothing, you will lose all your deposit.” Adolescents: “Suppose you were given a task to make an action plan, and you need to make a choice. Depending on the outcome you choose, you will loss (or earn) a certain amount of money”). The participants were required to choose between a risk-aversion option with known results (A. a sure option) and a risk-seeking option with known probability (B. an uncertain option) in each question. The expected values of the two choices were equal. Question order was balanced among the participants.

Procedure

Due to the impact of COVID-19, this study was conducted online. Three participants in each group were asked to log into the Tencent Meeting app at the same time and enter the designated meeting room as required. The participants were asked to have their microphones and cameras on throughout the process in a quiet environment. First, each of the three participants in a group was asked to click a questionnaire link (https://www.wjx.cn/) to complete the individual decision-making questions independently, and then the entire group was asked to make a decision after a discussion. The participants had 2 min to discuss each question (4 questions in total). Then, the experimenter entered the meeting room and asked for their joint decision. The participants were informed that the discussion process was recorded after the experiment was finished (see Fig. 1). All participants approved the researcher’s use of the video. The participants received 30 RMB (about $ 4.5) as compensation after completing the experiment.

Content analysis

We recorded the group discussions of all participants in the 61 groups and encoded the video. Each group’s discussion video was transcribed. The decision strategies were encoded as 6 mutually exclusive strategies (as shown in Table 1).

Statistic analysis

Since the dependent variable was categorical and some of the independent variables were repeated measurements, and with reference to Milch et al. (2009), a repeated logistic regression analysis was used to analyze the data. In the analysis of life problems and money problems, group number and individual number were incorporated into the subject variables; the decision-making form was incorporated as within-subjects variable into the model; and age was incorporated into the model as a between-subjects independent variable. Previous studies have shown that individuals behave differently in gain and loss frames (Kessler et al., 2017; Tversky & Kahneman, 1991). Therefore, we analyzed the two frames (the gain and the loss frame) separately.
Adolescent vs. adult decisions

We first analyzed the age difference in the individual decision-making condition. The age difference under each frame type was not significant. In the gain frame, the main effect of age was not significant ($\chi^2(1) = 2.42$, $p = .120$). In the loss frame, the main effect of age was also not significant ($\chi^2(1) = 1.35$, $p = .246$).

Individual vs. group decisions

The repeated logistic regression analysis of 2 (ages: adults vs. adolescents) * 2 (decision-making conditions: individual vs. group) under each frame type was conducted.

In the gain frame, the results showed that the main effect of the decision-making condition was not significant ($\chi^2(1) = 0.75$, $p = .387$); the two-order interaction was not significant ($\chi^2(1) = 0.00$, $p = .997$), but the main effect of age was significant ($\chi^2(1) = 2.27$, $p = .039$). That is, in both the individual and group decision-making conditions, adolescents are more risk seeking than adults (see Fig. 2a).

In the loss frame, the analysis of 2 (ages: adults vs. adolescents) * 2 (decision-making conditions: individual vs.
individual vs. group) under each frame type were as follows: in the gain frame, the results showed that the main effect of age was significant ($\chi^2(1)=9.49, p=.002$), while the main effect of condition was not significant ($\chi^2(1)=0.21, p=.643$), and the two-order interaction was not significant ($\chi^2(1)=0.21, p=.643$; see Fig. 3a).

In the loss frame, the results showed that the main effect of age was significant ($\chi^2(1)=4.17, p=.041$), and the main effect of condition was significant ($\chi^2(1)=4.05, p=.044$); however, the two-order interaction was not significant ($\chi^2(1)=2.26, p=.137$). That is to say, the adolescents were significantly more risk averse than the adults, and the group decisions were more risk averse than the individual decisions. However, descriptive statistics showed that the proportions of risk seeking in the individual and group decision-making conditions among the adolescents were 61.9% and 38.5%, respectively. For adults, the differences between group decision-making and individual decision-making were not significant for life problems.

**Money problem**

**Adolescent vs. adult decisions**

We also first analyzed the age difference in the individual decision-making condition in this session. In the gain frame, the main effect of age was significant ($\chi^2(1)=4.26, p=.039$). Under this frame, the adolescents were more risk averse than the adults; the proportion of adolescents seeking risk was 33.3%, and 48.5% of the adult participants chose to take risks (as shown in Fig. 3a). In the loss frame, the main effect of age was not significant ($\chi^2(1)=0.29, p=.587$).

**Individual vs. group decisions**

The results of repeated logistic regression analysis of 2 (ages: adults vs. adolescents) * 2 (decision-making conditions: individual vs. group) under each frame type were as follows: in the gain frame, the results showed that the main effect of age was not significant ($\chi^2(1)=0.05, p=.892$), and the main effect of condition was not significant ($\chi^2(1)=1.72, p=.190$), but the two-order interaction was significant ($\chi^2(1)=4.96, p=.026$). The differences between group decision-making and individual decision-making in different age groups were further analyzed. The group decision-making of adolescents was riskier than individual decision-making ($p=.027<.05$, see Fig. 2b): the proportions of risk seeking and risk averse were equally 50% when the participants made decisions at the individual level, while under the group decision-making condition, 65.4% of the adolescents chose risky options. For adults, the differences between group decision-making and individual decision-making were not significant for life problems.

**Group decision strategy**

After further coding and analyzing the video of the participants in the group discussion process, we obtained many
Unclear. This study explored the difference between individual and group decision-making in risky contexts among adolescents and young adults. The study found that the adolescents were not always more risk seeking than the adults when making decisions individually. Peers' influence on the adolescents under the loss frame condition was domain specific. Adolescents were more risk seeking in groups when facing life problems, but less risk seeking in money problems, while the adults were more stick to their choice in groups. This study shed light on the understanding of adolescents' social development.

**Age differences in individual risky decisions**

The current study found that adolescents are not more risk seeking than adults when making decisions individually, which does not confirm Hypothesis 1 that “Adolescents make more risky decisions than adults”. Under a gain frame of money problems, adolescents are even more risk averse than adults. This result of money problems is consistent with the study of Chien et al. (1996). They found that the proportion of adolescents taking risks in the gain and loss frames was very similar to that of our study. Kwak et al. (2015) also found that adolescents were more risk averse in framing tasks related to money problems. The results of life problems were consistent with Willoughby, Heffer, Good, et al. (2021), who found that adolescents were not more risk-taking than adults on life-related problems. Thus, neurodevelopmental imbalance models are not supported in our study.

Further analysis of the participants' explanations of their decision-making processes showed that approximately half...
of the adults tended to avoid risks because “life needs to be cautious, cannot gamble with it”. In addition, adults could accept the fact that investment itself means risk, and they could bear the outcome (e.g., “Money comes from risk”). This view leads them to take risks in money problems. Moreover, the explanations given by adolescents indicated that nearly half believed they need to “Keep as much as you can get”, leading them to be more risk averse in the face of money problems.

Adolescence is generally considered a highly risk-seeking period (Defoe et al., 2015). This study, along with other studies (Ciranka & van den Bos, 2021; Willoughby, Heffer, Good, et al., 2021), revealed that risk-taking decisions depend on domains (money vs. life) and context (group or individual).

**Group vs. individual decision-making**

The difference between group decision-making and individual decision-making among adolescents under the loss frame condition (life domain: riskier in the group; money domain: more risk averse in the group) shows a domain-specific effect of peer influence (Braams et al., 2019), which was not supported by the social deliberation effect but partly verified Hypotheses 2 and Hypotheses 3. Harris (1998) pointed out that approximately 50% of the variation in adolescent personality is inherited, and the remaining 50% reflects the influence of the environment, which mainly reflects the influence of peers. However, the existence of peers may not always lead to risk-seeking results (Braams et al., 2019). Peers’ influence may meanwhile lead them to more prosocial or antisocial behaviors (Blakemore, 2018), depending on the norms in the peer group. For example, when the norms held by peers conform to social norms, the consequences will be positive or prosocial, while when they are associated with antisocial or risk-taking behaviors, the consequences will be negative or antisocial (Paricio et al., 2020). When facing life problems, peer groups make adolescents more risk seeking, possibly due to their relatively weak awareness of life limitations (Shook et al., 2021). Shook et al. (2021) pointed out that individuals are more likely to pay attention to the present and become more aware of the consequences of poor health and safety behaviors as they get older. Notably, the peer effect found in this study occurred under the loss condition, illustrating that losses affect behavior more than gains of the same magnitude, which is consistent with the views of Kessler et al. (2017) that the disappointment of losing points through taking risk may be stronger than the excitement of winning points through safe actions and that of Willoughby, Heffer, van Noordt, et al. (2021) that the peer effect in adolescents is specific to loss rather than gain conditions. This may be because adolescents tended to pay more attention to punishment (i.e., loss conditions) rather than rewards (gain conditions).

Our findings that in the life domain, adolescents in peer groups are more risk seeking; in the money domains, adolescents tend to be risk averse in individual decision-making, while group discussion polarizes this tendency. According to content analysis of the group decision-making process, most adolescents tended to use the strategy of “one person proposes an idea, others follow”, which reflects adolescents’ tendency to conform with peers, since social risks of being rejected by their peers outweigh the other negative consequences that may result from the decision (Blakemore, 2018), which is a way to enhance, protect or strengthen their social ties (Somerville et al., 2019). Copying the same risky behavior as peers can be seen as adaptive and rational (Rommer et al., 2017).

This study found adults were more likely than adolescents to stick to their choices in groups. This is consistent with Milch et al. (2009), who showed no significant differences between group and individual decision-making among adults when faced with life problems. In particular, the world is now under the threat of COVID-19, which may lead individuals to be more cautious about life-related risky choices, and this attitude is more stable and less susceptible to the influence of others (Olmastroni et al., 2021). In addition, the adults in our study used the “minority follow majority or voting” strategy most frequently (70% of the groups). This strategy is different from the adolescent strategy of “one person proposes an idea, others follow”. Compared with adolescents, adults may be less likely to be affected by the psychological pressure of peer assessment (Blakemore, 2018).

**Limitations and future directions**

Due to the impact of COVID-19, this research was carried out online, and the sample of adolescents was relatively small. Interaction based on the internet and online media has become an important way to support remote work, online learning, and online collaboration (Favale et al., 2020). It is necessary to compare face-to-face and online group decision-making. A study indicating face-to-face and online versions reveals a remarkably high consistency between individual decisions but shows a large difference in the consensus responses reached by group discussions (Keshmirian et al., 2022). Face-to-face (but not online) interaction tended to promote more diverse consensus opinions (Keshmirian et al., 2022), and Schneider et al. (2002) found that online group discussions required shorter comments (sometimes just a few words of agreement) than face-to-face interaction. It is necessary to explore whether there is a difference
in group risky decision-making between online and face-to-face interaction among adolescents in the future.

Conclusions and practical implications

This study explored the difference between individual and group decision-making in risky contexts among adolescents and young adults. In fact, the adolescents were not always more risk seeking than the adults. Moreover, peers’ influence on the adolescents was domain specific. The adolescents were more risk seeking when facing life problems, but less risk seeking in money problems. The adults were more stick to their choice in groups. This study implies that it is critical to understand under what condition adolescents are most susceptible to social influence of peers so that guidance for them can be more accurate.

Supplementary Information

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Data availability

The main data for this study are available on Psychological Science Data Bank at https://doi.org/10.57760/sciencedb.o00115.00063.

Declarations

The authors have no conflicts of interest to disclose.

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