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Older and Younger Adults' Interactions with Friends and Strangers in an Iterated Prisoner's Dilemma

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Abstract

This study examined age-related differences in behavioral reactions to interpersonal conflict within an iterated prisoner's dilemma (PD). Participants completed an iterated PD game alone and with a partner, either a stranger or a friend who accompanied them to the session. The partner, however, was actually a program that occasionally behaved selfishly or always reciprocated. Afterwards, participants formed trait impressions of their partner's morality and competence. Participants cooperated more with friends than strangers and more with reciprocating partners than selfish ones. Older adults cooperated more with selfish partners and offered more favorable impressions than did younger adults. Overall, perceived partner trait morality was positively associated with cooperative behavior. Relative to younger adults, older adults were more passive during conflict but grew less so as selfishness continued. This passivity co-occurred with more favorable partner impressions and better objective performance, suggesting a degree of calibration not shown by younger adults.

Keywords

social cognition; economic games; interpersonal conflict; cooperation; prisoner's dilemma

Younger and older adults approach interpersonal conflict with different goals in mind. Older adults focus on their relationships and maintaining affiliative bonds, whereas younger adults are self-focused, seeking autonomy (Carstensen, 2006; Hoppmann & Blanchard-Fields, 2010). Consequently, older adults resolve conflicts with strategies balancing direct action with passive emotion regulation (Blanchard-Fields, Stein, & Watson, 2004), whereas younger adults focus on being proactive even if that requires being confrontational toward others (Birditt & Fingerman, 2005). Few studies capture the evolving process by which an interpersonal conflict is resolved by older adults (e.g., Carstensen, Gottman, & Levenson, 1995). The current study investigated younger and older adults' behaviors during a conflict

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with either a stranger or a friend that played out in a controlled lab setting through a computerized interactive iterated prisoner's dilemma (PD) game.

Investigating Age Differences in Conflict Resolution

In old age, negative emotions experienced during social interactions predict decrements in well-being (Birditt, 2014). Emotion-focused problem-solving strategies play a key role in maintaining the well-being of older adults (Blanchard-Fields, 2007) and contribute to their greater efficacy in resolving interpersonal conflict relative to younger adults (Blanchard-Fields, Mienaltowski, & Seay, 2007). Although passivity does not directly resolve interpersonal conflict, it prevents complex social problems from escalating by reducing negativity (Birditt & Fingerman, 2005). Dwelling on negativity undermines goals that older individuals have for social interaction (Sorkin & Rook, 2006), but reducing negativity in social interactions buffers an older adult's well-being and facilitates greater relationship satisfaction (Charles & Carstensen, 2008; Newsom, Rook, Nishishiba, Sorkin, & Mahan, 2005; Rook, Luong, Sorkin, Newsom, & Krause, 2012).

Studies examining strategy selection for hypothetical problems and retrospective accounts of interpersonal conflicts have shed significant insights into age differences in interpersonal everyday problems solving (Blanchard-Fields, 2007). However, nominated hypothetical solutions to interpersonal problems could be impacted by social desirability, in a manner similar to reports of well-being and personality across adulthood (Fastame & Penna, 2012; Soubelet & Salthouse, 2011). Additionally, the quality of the contextual experience in which participants are immersed while resolving a conflict may differ from imagining how one might react. According to construal level theory, predicted behavior is abstracted beyond the present circumstance and reflects contextually relevant perceptual and visceral inputs less strongly than might actual behavior (see Trope & Liberman, 2010 for a review). Behavioral predictions for psychologically distant events may be more reflective of participants' beliefs and values about the essential elements of situations than of behaviors that will be displayed in real-time during a conflict. There is much to learn from actual behavior that hypothetical situations likely do not capture. For instance, age differences in real-time behavior during conflict have been examined during interactions in which couples discuss issues that elicit a difference of opinion. In this context, older adults provide social support to their partners to lessen conflict (Carstensen et al., 1995; Levenson, Carstensen, & Gottman, 1994).

Studying Interactions Using the Prisoner's Dilemma and Other Social/ Economic Games

Interactive games set up in the lab allow for one to investigate how social dilemmas may differentially impact the emotionality and behavioral reactions of younger and older adults as they experience obstacles in a social interaction in real-time. The current study uses an interactive social and economic game called an iterated prisoner's dilemma to study interpersonal conflict under controlled conditions. The prisoner's dilemma (PD) paradigm historically stems from situation in which two people suspected of committing a crime are questioned separately (Luce & Raifa, 1957). Each individual could independently admit or deny guilt for the crime, and the resulting combination of pleas influences culpability. If

both deny guilt, then both can minimize the likelihood of jail time, but, if both admit guilt, they both will likely serve jail time. If the suspects do not both respond the same way, one may implicate the other in exchange for leniency, causing one to serve far more jail time than the other.

Behavior in games like the prisoner's dilemma has been investigated across many formats. In a traditional "one-shot" prisoner's dilemma game, as described above, players are presented with a matrix of payoffs, a single choice is made by each player, and the players are presented with the outcome of the choices made (von Neumann & Morgenstern, 2007). The current study used an iterated prisoner's dilemma in which players make sequential choices in real-time, so one person makes a choice which is then followed by a subsequent choice by the other player (Axelrod, 2006). One person's choice impacts the other person's choice in two ways (Luce & Raifa, 1957). First, when one person makes a choice, that choice restricts the choice of the other player. For instance, a self-interested choice by one player will reduce the possible reward that the other player can earn on their turn. However, a mutually beneficial choice will grant the other player access to choice options that allow for greater reward to be collected. Second, the amount of reward collected by a person signals to the other player what his or her priorities are for the interaction. Specifically, if one chooses to collect additional reward at the expense of the other player, the other player may observe this behavior as a possible act of selfishness or competitiveness. However, if one chooses to forgo additional reward to give the other player an opportunity to collect greater reward, then the other player may observe this behavior as a cooperative act for mutual benefit.

Choices that are made in the PD paradigm are often linked to cooperative and competitive intentions (Raihani & Bshary, 2011). For instance, making mutually beneficial choices reflects an intention to facilitate maximizing the reward earned by both parties in the game and requires each player to be willing to sacrifice more personal reward to allow the other person to benefit (Andreoni & Miller, 1993). On the one hand, when play is simulated across successive partners, cooperative individuals can increase collective cooperation by modeling cooperative expectations in a manner akin to teacher-learner relations (Szolnoki & Szabó, 2007) and by promoting through collective wisdom the success of those who cooperate despite the presence of those who do not (Szolnoki, Wang, & Perc, 2012). On the other hand, making self-interested choices breeds competitiveness because it thwarts the other player's ability to maximize their overall reward and encourages a shift of focus to simply outperforming the other player (Houston, Kinnie, Lupo, Terry, & Ho, 2000). In an iterated PD, one might expect choices to evolve over time as partners take turns and accrue more information about the other partner's intentions (Luce & Raifa, 1957).

Although limited, research on age differences in social and economic games is becoming more prevalent. For instance, in a twin study examining cooperative behavior during an iterated prisoner's dilemma game, age was moderately correlated with greater cooperation to reach a mutual goal ($r = .22$) independent of genetic relatedness (Segal & Hershberger, 2006, p. 40), suggesting that advancing age might lead to greater generosity or sharing in social economic game environments. This said, cooperation impacts the behavior of progeny as well. Offspring of those who tend to cooperate have through simulations been shown to

contribute cooperative outcomes to the PD, suggesting that successive generations may perpetuate the cooperative gains of their forebearers (Szolnoki, Perc, Szabó, & Stark, 2009). Independent of these modeled inheritance-related effects, however, the behavior of older adults in other economic games shows that older adults are more likely than younger adults to make fair offers from the start and to reject unfair offers in Ultimatum game (Bailey, Ruffman, & Rendell, 2013; Beadle, Sheehan, Dahlben, & Gutchess, 2015; Roalf, Mitchell, Harbaugh, & Jankowsky, 2012). Across multiple economic games, including the PD, and in a large sample (n = 408), advancing age was associated with more prosocial behavior (r = . 28) in younger and middle aged adults (Matsumoto, Yamagishi, Li, & Kiyonari, 2016).

Current Study

The current study extends this past research by implementing a computerized iterated PD game in which partners who are either younger or older take turns in the game, choosing either mutual benefit through cooperation or selfish personal gain. Cooperation requires one to forgo a slightly larger short-term reward in the hope of attaining greater long-term reward, and, rationally speaking, is the best choice if the objective is to earn as much reward as possible. However, cooperation requires trust in reciprocation (Baker & Rachlin, 2001), making the iterated PD an excellent environment to create a conflict by manipulating a partner's willingness to cooperate. Additionally, social proximity, like genetic relatedness (Segal & Hershberger, 1999) and friendship (Majolo et al., 2006), fosters greater cooperation in iterated PD games. The current study investigated older and younger adults' behaviors when interacting with partners whom they believed to be either their friends or strangers but who actually were computer programs designed to reciprocate choices (i.e., implement a tit-for-tat strategy) or to behave relatively more selfishly to create conflict. Both younger and older adults were expected to cooperate more with reciprocating partners than with selfish partners, and to cooperate more with friends than with strangers. Given that older adults are more forgiving (Cheng & Yim, 2008; Steiner, Allemand, & McCullough, 2011) and more passive during interpersonal conflict (Birditt & Fingerman, 2005; Blanchard-Fields, 2007) than younger adults, older adults were expected to be more likely to forgive and behave in a cooperative manner when faced with a selfish partner. This was expected to be shown by a higher number of continued cooperation attempts, even following partners' selfish choices.

In addition to examining behavioral reactions to one's partner during the iterated PD game, participants' impressions of their partners were examined after the interaction unfolded. Cooperation and perceived morality are related (e.g., Tomasello & Vaish, 2013), and when hypothetical social targets display selfish negative morality-related behaviors after first displaying cooperative positive morality-related behaviors, older adults weigh these negative behaviors more so than do younger adults in morality-related trait judgments (Hess & Auman, 2001; Hess, Bolstad, Woodburn, & Auman, 1999). Hess and colleagues have proposed that negative behaviors are more diagnostic of morality-related judgment than are positive ones, and that focusing on this negative information is adaptive for older adults' judgments. In keeping with this research, participants in the current study evaluated the other player after the interactive iterated PD round by providing impressions of the other player's morality, competence, and general likeability. This extends prior research by examining the impact of a real-time social interaction on trait impressions of the interaction partner. Of

interest was whether a partner's selfish behavior would yield age differences in trait morality judgments.

In sum, the current study examines how younger and older adults interact with social partners who are either friends or strangers through an iterated PD game that was designed (a) to assess the typical progression of an interaction when the participant's partner reciprocates his or her own behavior on each turn and (b) to assess whether age differences emerge when participants interact with a partner who injects self-interest into the interaction when cooperation would otherwise lead to the best outcome for both players.

Method

Participants

Younger (n = 147; 57% men; ages 18-24 years) and older adults (n = 136; 43% men; ages 56-82 years) were recruited from a southeastern metropolitan region. Participants were either recruited to sessions alone or with a friend. Those accompanied to the lab by a friend believed they would interact with that friend, even though they did not. Both members of the friend pair took part in the session. No limits were placed upon participants with respect to whom in their life could qualify as a friend and attend the experimental session; both members of the pair, however, completed a short packet of questionnaires about the relationship prior to the session.[1] Older adults (M = 13.5 years, SE = 1.6 years) reported having been in longer relationships with their friend than did younger adults (M = 2.4 years, SE = 0.3 years), $t(70.42) = 6.69$, $p < .001$, $d = 1.15$. However, relative to older adults, younger adults (on a 1-6 scale; YA: M = 5.3 or "almost every other day", SE = 0.1; OA: M = 2.7 or close to "3-5 times per month", SE = 0.2) reported more frequent visits with their friend, $t(139) = 11.93$, $p < .001$, $d = 2.00$, and being closer with their friend (1-4 scale; YA: M = 3.4 or between "moderately close" and "very close", SE = 0.1; OA: M = 3.1 or "moderately close", SE = 0.1). There were no age differences in how well the participants believed they knew their friend (on a 1-4 scale; Ms = 3.2-3.3 or "moderately well", SEs = 0.1) nor in how well the participants believed that their friend knew them (1-4 scale; Ms = 3.1-3.2 or "moderately well", SEs = 0.1), ts(139) < 1.24, ps ≥ .216. There were also no age differences in participants' perceived relationship quality with the friend (1-5 scale; Ms = 4.0-4.1 or "very good", SEs = 0.1), $t(139) = 0.86$, $p = .393$, nor in the likelihood that the friend was the participant's best/closest friend (YA = 64%, OA = 68%), Mann-Whitney U = 2379, $Z = 0.53$, $p = .60$.

The sample was predominantly Caucasian (68%). Over 90 percent (90.1%) were non-Hispanic. Younger and older adults had comparable education levels (i.e., some college) and were in good to excellent health. Younger adults outperformed older adults on an inductive reasoning test, whereas older adults outperformed younger adults on a test of verbal ability (Letter Sets and Advanced Vocabulary; Ekstrom, French, Harman, & Dermen, 1976). Younger adults also scored higher than older adults on a test of processing speed (Digit

[1]Friend pairs consisted of individuals who belonged to the same gender but could differ in age. Between age groups, there was a larger difference in the age of the members of the older friend pairs (M_{diff} = 4.7 years, SD_{diff} = 4.7 years) than of the members of the younger friend pairs (M_{diff} = 0.7 years, SD_{diff} = 0.8 years), $t(36.07) = 4.98$, $p < .001$, $d = 1.19$. One of the older friend pairs included a 48 year-old woman and a 72 year-old woman. The data from the 48-year old were excluded from all analyses.

Symbols Substitution; Salthouse, 1992). Means and standard deviations for cognitive measures are reported in Table 1. Most younger adults received university course credit for participating, and some received an honorarium. Older adults received an honorarium for participating. Due to a computer malfunction, data from three younger adults from the iterated PD Interactive Round were lost. One older participant was dropped from analyses for not following instructions. Table 2 displays the sample size for each experimental condition as a function of participant group assignment.

Materials

Iterated Prisoner's Dilemma Game.—The iterated PD game has been used in prior research (Baker & Rachlin, 2001; Brown & Rachlin, 1999) and implemented for the current study using E-prime software (Psychology Software Tools, pstnet.com). At the start of the game, participants selected a token to represent their identity. Participants were presented with a game board, as depicted within Figure 1a, and given instructions. Each round involved completing multiple turns opening doors using keys and collecting the coins (nickels) from behind each door. Participants were told that the objective was to collect as many nickels as possible during each round. The nickels earned were reflected in a coin total that accumulated in each round. Yellow doors (A/B) required a yellow key and blue doors (C/D) required a blue key to open. In the figures, the yellow and blue shading used during the experiment is replaced with white and gray shading, respectively to facilitate black and white reproduction. A set number of nickels and the key that would be provided for use on the next turn were visible through a window at the bottom of each door so that participants could always anticipate the outcome of their choice. Throughout the study, pay-offs behind each door remained the same. Door color also remained the same, and all doors could be unlocked as many times as wanted. Participants played the game in their own testing room without others present, and the experimenter sat outside. Participants were not compensated for their participation based on their performance in the rounds of the game, and the pay-off amounts for choices made on each turn were identical to those used by Baker and Rachlin (2001).

Alone Round.—In the alone round, participants always received the pay-off behind the door for each choice that they made. The key included in the pay-off was then available to them for their next door choice. Participants first completed a practice round of eight turns before a full round of 32 turns. Participants unlocked a door using the key (blue/yellow) made available to them by their previous choice prior to that turn. A nickel total was updated to reflect the number of coins earned, and participants were reminded of the key available for use on the next turn via the appearance of the key in a box on the top of the display. Everyone started each round with what they were told was a randomly selected key, but which was always yellow. The objective optimal solution to the game was to repeatedly use the yellow key to open Door A, maximizing long-term reward. As in previous research, the percentage of choices yielding a yellow key was recorded (Baker & Rachlin, 2001; Brown & Rachlin, 1999). Note that choosing to open Door B with a yellow key would yield more reward than opening Door A. However, on the next turn, the participants would have then limited themselves to choosing between Doors C and D, each offering lower pay-offs. Across multiple turns, the highest average reward was attained by always choosing Door A

(i.e., 5 nickels per turn). Figure 1b and 1c depict a sample turn taken by a participant within the Alone Round.

Interactive Round.—In this round, participants believed that they were playing the game with either a friend or a stranger. When participants were recruited, their materials indicated whom they would play in the game. Roughly half of the sample played with "other players" (i.e., strangers), whereas half played with a friend. This constituted the operationalization of two levels of social distance (friend vs. stranger). Participants could not talk directly with their partner and interacted only through the game's choices. Participants in the stranger condition did not know their partner's gender, but were told that the individual was a member of the same age group (i.e., "senior citizen from the community"). During the Interactive Round, the rules of play were updated such that, when a player opened a door, that player would earn the coins behind the door but would pass the key to the other player for use on the next turn. Each player's choice restricted the subsequent choice of the other player on the very next turn. The payoff amounts for each door were identical to those used in the Alone Round. The objective of the game remained to earn as many nickels as possible. No mention was made of cooperating or competing with the other player. As in the Alone Round, the participant took 32 turns, as did the other player.

Within the Interactive Round, the choices made by the players could reflect either self-interest or mutual benefit (Brown & Rachlin, 1999). When a player had a yellow key, selecting Door A required the player to forgo some reward and reflected the player's willingness to cooperate so that both partners had an opportunity to meet the goal of earning as much reward as possible. When a player chose Door A, s/he was supporting the other player's interest in maximizing reward by giving the other player a yellow key that could be used to open either Door A or Door B. Consistent with previous research, if a person opened Door B with the yellow key, that person was considered to be defecting from the mutual goal of maximizing reward, focusing on maximizing only his or her own reward. Choosing Door B reflected self-interest because it forced the other player to use a blue key on the next turn to either open Door C or D, both of which offered substantially less reward than Doors A and B. Note that for a blue key to be available on any turn, one player had to be focused on their own gains instead of on the mutual interest that both parties had to maximize reward. With a blue key, one had to choose between Door C or Door D. Door C offered the least reward, but also offered the chance for a re-emergence of cooperation if the other player used the yellow key they received to open Door A. Door D offered a better reward than Door C and allowed one to retaliate by handing over the blue key to the defecting, self-interested partner, but did not allow the re-emergence of cooperation. Participant choices within the Interactive Round were monitored relative to the proportion of turns in which a yellow key was passed to the other player (Doors A/C) reflecting self-sacrifice and cooperation to maximize long-term gain (Baker & Rachlin, 2001; Brown & Rachlin, 1999), or the (frequency of selecting Door A or Door C)/(total number of choices).

Participants were randomly assigned to interact with one of two programs simulating human behavior: (1) the "Tit-for-tat" (TFT) partner that reciprocated every choice made by the participant, or (2) the "Selfish" partner who made self-interested choices on 25% of the trials, regardless of participant's behavior, and then reciprocated on 75% of the turns. On the

first two turns, the Selfish partner reciprocated the participant's choices to create the illusion of being willing to cooperate. On the third turn and then again randomly seven more times during the round, the Selfish partner made a self-interested choice, instigating conflict by behaving in a manner inconsistent with a cooperative goal that supported the mutual benefit of both players (Baker & Rachlin, 2001).[2] Participants could see their partner's game token and score, as shown in panels a-d of Figure 2. This figure depicts a sample turn taken by each partner during the Interactive Round, specifically showing what would happen when the Selfish partner program made a self-interested choice. The computer-simulated partners randomly varied their response times, 2-6 seconds for younger adults and 2-10 seconds for older adults.

Note that participants in the stranger condition completed two interactive rounds, one with the TFT partner and one with the Selfish partner programs in counterbalanced order. In contrast, participants in the friend condition completed only one interactive round with either the TFT or the Selfish partner program. To allow comparison without possible contamination from task carry-over effects, we analyzed only data from the first interactive round for stranger condition participants.

Trait Impression Ratings.—After the Interactive Round, participants described the other player by rating the extent to which they agreed or disagreed (7-point Likert rating; *1 = strongly disagree* / *4 = neither agree nor disagree* / *7 = strongly agree*) that 25 different traits described the other player: likeable, intelligent, kind, trustworthy, charitable, friendly, honest, competent, loyal, passive, selfish, stubborn, unfaithful, annoying, uncaring, lazy, inexperienced, hostile, cooperative, competitive, masculine, feminine, impulsive, independent, and curious. Consistent with past research (Hess & Auman, 2001; Hess & Kotter-Grühn, 2011; Hess, Osowski, & Leclerc, 2005), trait impressions were averaged to reflect competence (e.g., competent and intelligent; α =.64) and morality (e.g., honest and trustworthy; α =.83). Likewise, a global evaluation score was calculated by averaging friendliness and likeability ratings for the other player (α =.87).

Procedure

Participants provided their informed consent to take part in the study. Sessions included one or two participants who played multiple rounds of the iterated PD game while each isolated from any other participants in a testing room. Participants interacting with a stranger were informed that additional same-age players were simultaneously taking part in the experiment in another testing location. Participants were instructed as to how to play the game, first alone and then with the other player. After the Interactive Round, participants provided impression ratings of the other player. Next, cognitive abilities tests were administered, and

[2]Prior research suggests that when the probability of reciprocation (POR) by a non-human, computer partner is 75% in an iterated PD and known to the participant (e.g., signaled via spinner), there exists enough of an incentive for the participant to cooperate despite the occasional self-interest of the gaming partner (Baker & Rachlin, 2001). However, when the participant believes that they are interacting with another person and the 75% POR is not obvious, participants treat this probability no different than chance (50% POR) and consequently shift toward defection when their cooperation is met with self-interest. A 75% POR creates some ambiguity in the intention of the gaming partner and creates the possibility for either cooperation or competitiveness, depending upon whether or not the participant is receptive to and perceives the cooperative signal from their gaming partner or instead focuses on the partner's occasional defections.

participants were probed for suspicion of deception used during the game.[3] Participants were then debriefed as to the purpose of the experiment and the true nature of the game.

Results

Iterated PD Performance

Alone Round.—An independent samples t-test compared younger and older adults on the percentage of turns in which a door was opened that granted access to a yellow key (i.e., prioritized larger long-term gains over short-term gains) during the Alone Round. Younger adults (M = 89.0%, SE = 1.7%) more consistently did this than did older adults (M = 67.6%, SE = 2.9%), $t(281) = 7.58$, $p < .001$, $d = 0.89$. To examine if performance improved as the round progressed, a mixed-model ANOVA using Age Group as a between-subjects factor was performed to compare the average responses for the first and last eight turns of the round. It revealed that main effects of age group, $F(1, 281) = 58.22$, $p < .001$, $\eta_p^2 = .172$, and round progression, $F(1, 281) = 33.19$, $p < .001$, $\eta_p^2 = .106$, were qualified by an age group × round progression interaction, $F(1, 281) = 24.95$, $p < .001$, $\eta_p^2 = .082$. Younger adults consistently prioritized long-term over short-term gains (Turns 1-8: M = 88.4%, SE = 2.1%; Turns 25-32: M = 89.4%, SE = 2.1%), but older adults' choices evolved to increasingly prioritize long-term gains (Turns 1-8: M = 60.9%, SE = 2.2%; Turns 25-32: M = 74.1%, SE = 2.2%). Although younger adults were more likely than older adults to display the optimal choice in the final eight-turn block of the Alone Round, both age groups displayed behavior consistent with understanding that the goal of the iterated PD game was to maximize reward by prioritizing long-term gain.

Interactive Round.—Cooperation was aggregated into four 8-turn segments that reflected the timing within the round as it progressed. This was examined in a mixed-model ANOVA which included Age Group (2: young, old), Gender (2: men, women), Social Distance (2: stranger, friend), and Partner Type (2: TFT, Selfish) as between-subjects factors and Round Progression (4: 1-8, 9-16, 17-24, 25-32) as a within-subjects factor. The analysis revealed that main effects of partner type, $F(1, 263) = 34.43$, $p < .001$, $\eta_p^2 = .116$, social distance, $F(1, 263) = 7.38$, $p = .007$, $\eta_p^2 = .027$, and round progression, $F(3, 789) = 19.32$, $p < .001$, $\eta_p^2 = .068$, were qualified by age group × partner type, $F(1, 263) = 3.99$, $p = .047$, $\eta_p^2 = .015$, gender × partner type, $F(1, 263) = 5.34$, $p = .022$, $\eta_p^2 = .020$, and round progression × partner type interactions, $F(3, 789) = 29.82$, $p < .001$, $\eta_p^2 = .102$. Figure 3 depicts younger and older adults mean levels of cooperation with strangers and with friends over each 8-turn segment of the interactive round separately by (a) the Tit-for-Tat partner and (b) the Selfish partner.

Participants cooperated more with friends (M = 52.1%, SE = 3.0%) than with strangers (M = 40.5%, SE = 3.1%). Both men (TFT: M = 52.5%, SE = 4.3%; Selfish: M = 37.4%, SE = 4.2%) and women (TFT: M = 65.0%, SE = 4.2%; Selfish: M = 30.2%, SE = 4.3%)

[3]At the end of the experimental session, participants were asked a short series of questions about their experience, including a check as to whether they believed they were playing with a real person: "Some people say that it's hard to know if they were playing with a real person because they don't actually see them playing the game. Did it ever seem like you were not interacting with a real person?". None of the participants in the Friend condition responded affirmatively. For the Strangers condition, five younger adults and one older adult responded affirmatively. The data from these six individuals were excluded from all analyses.

cooperated more with the Tit-for-Tat partner than the Selfish partner, $t(137) = 5.75$, $p < .001$, $d = 0.98$, and $t(138) = 2.63$, $p = .01$, $d = 0.44$, respectively, but the difference was larger for women ($M_{diff} = 33.7\%$, $SE_{diff} = 5.9\%$) than for men ($M_{diff} = 16.5\%$, $SE_{diff} = 6.3\%$). Additionally, younger and older adults cooperated equally well with the Tit-for-Tat partner, $t(138) = 0.50$, $p = .62$, $d = 0.09$, but older adults cooperated more than younger adults with the Selfish partner, $t(138) = 2.30$, $p = .023$, $d = 0.39$. The round progression × partner type interaction was driven by a decline in cooperation with the Selfish partner from the beginning to the end of the round. This is depicted in Figure 3 separately by age group.

An analysis was also performed to examine the duration of conflicts started by participants playing with the Tit-for-Tat partner. Those who did not start a conflict (34.3%) were excluded from consideration. An Age Group (2) × Social Distance (2: stranger, friend) ANOVA performed on the number of consecutive selfish choices (i.e., choosing Door B then Door D repeatedly) yielded a main effect of age group, $F(1, 87) = 10.44$, $p = .002$, $\eta_p^2 = .107$. After initiating a conflict, younger adults ($M = 18.1$, $SE = 2.1$) made more consecutive self-interested choices than did older adults ($M = 8.9$, $SE = 1.9$).

Retaliation in response to conflict was examined for those who were taken advantage of by the Selfish partner, disrupting cooperation on the part of the participant. Recall that the Selfish partner was programmed to defect on the third turn and then again randomly on 7 more turns throughout the Interactive Round. This defection was used to operationalize the commencement of a conflict between the two partners in the Interactive Round. If participants were making cooperative choices during the Interactive Round, they would notice the defection. Younger (71.2%) and older adults (82.1%) were equally likely to experience a conflict started by the Selfish partner through a programmed defection, Mann-Whitney $U = 2180$, $Z = 1.11$, $p = .27$, and were equally likely (YA = 67.3%; OA = 61.8%) to respond in a retaliatory manner (i.e., reciprocate with a self-interested choice, Door D), Mann-Whitney $U = 1396$, $Z = 0.37$, $p = .71$. Two additional ANOVAs were conducted with Age Group and Social Distance as between-subjects factors to examine (a) the number of insults experienced at the hands of the relatively Selfish partner, and (b) the number of times that participants responded to these insults in a conciliatory way (i.e., choose Door C). Both analyses revealed marginal main effects of age group. Older adults ($M = 3.8$, $SE = 0.3$) experienced more insults than did younger adults ($M = 3.0$, $SE = 0.3$), $F(1, 103) = 3.35$, $p = .070$, $\eta_p^2 = .031$, and older adults ($M = 3.3$, $SE = 0.3$) offered more conciliatory responses after being insulted than younger adults ($M = 2.4$, $SE = 0.3$), $F(1, 103) = 3.34$, $p = .071$, $\eta_p^2 = .031$.

Trait Impressions of Partners

Separate between-subjects ANOVAs were conducted to examine the impact of Age Group (2), Gender (2), Social Distance (2: stranger, friend), and Partner Type (2: TFT, Selfish) on the participants' morality, competence, and global positivity ratings of the other player.

Morality trait impressions.—Main effects of age group, $F(1, 261) = 18.77$, $p < .001$, $\eta_p^2 = .067$, partner type, $F(1, 261) = 52.75$, $p < .001$, $\eta_p^2 = .168$, and social distance, $F(1, 261) = 73.29$, $p < .001$, $\eta_p^2 = .219$, were qualified by age group × partner type, $F(1, 261) = 8.60$, p

= .004, η_p^2 = .031, and partner type × social distance interactions, $F(1, 261) = 6.88$, $p = .009$, η_p^2 = .026. Older and younger adults rated the Tit-for-Tat partner's morality (OA: $M = 5.5$, $SE = 0.1$; YA: $M = 5.3$, $SE = 0.1$) more highly than the Selfish partner (OA: $M = 4.9$, $SE = 0.1$; YA: $M = 3.9$, $SE = 0.1$), but older adults rated the Selfish partner more highly on morality than did younger adults, $t(135) = 4.47$, $p < .001$, $d = 0.77$. Strangers were viewed as less moral than friends, but the difference in morality between Selfish partner and the Tit-for-Tat partner was larger for friends (TFT: $M = 6.2$; $SE = 0.1$; Selfish: $M = 4.8$, $SE = 0.1$; $M_{diff} = 1.3$, $SE_{diff} = 0.2$) than for strangers (TFT: $M = 4.6$, $SE = 0.1$; Selfish: $M = 4.0$, $SE = 0.1$; $M_{diff} = 0.7$ $SE_{diff} = 0.2$), suggesting that participants might have expected more cooperation and reciprocity from friends than was observed in the Selfish partner condition.

Competence trait impressions.—Main effects of age group, $F(1, 262) = 8.51$, $p = .004$, η_p^2 = .031, partner type, $F(1, 262) = 15.67$, $p < .001$, η_p^2 = .056, and social distance, $F(1, 262) = 33.46$, $p < .001$, η_p^2 = .113, were qualified by an age group × gender interaction, $F(1, 262) = 4.99$, $p = .026$, η_p^2 = .019. Friends ($M = 6.1$, $SE = 0.1$) were rated more highly on competence than strangers ($M = 5.3$, $SE = 0.1$). The Tit-for-Tat partner ($M = 6.0$, $SE = 0.1$) was rated more highly on competence than the Selfish partner ($M = 5.5$, $SE = 0.1$). The age group × gender interaction was driven by younger men ($M = 5.3$, $SE = 0.1$) rating their partners as less competent than did all others (Ms = 5.8-5.9, SEs = 0.1).

Global positive evaluation.—Main effects of age group, $F(1, 262) = 9.23$, $p = .003$, η_p^2 = .034, gender, $F(1, 262) = 13.80$, $p < .001$, η_p^2 = .050, partner type, $F(1, 262) = 39.98$, $p < .001$, η_p^2 = .132, and social distance, $F(1, 262) = 72.05$, $p < .001$, η_p^2 = .216, were qualified by a partner type × social distance interaction, $F(1, 271) = 5.41$, $p = .021$, η_p^2 = .020. Older adults ($M = 5.3$, $SE = 0.1$) had a more favorable global impression of their partners than did younger adults ($M = 4.9$, $SE = 0.1$). Women ($M = 5.4$, $SE = 0.1$) had more favorable global impressions of their partners than did men ($M = 4.8$, $SE = 0.1$). Participants had a more favorable global impression of friends than of strangers, but the difference between the Tit-for-Tat and Selfish partners was smaller when the participants interacted with strangers (TFT: $M = 4.8$, $SE = 0.2$; Selfish: $M = 4.2$, $SE = 0.2$; $M_{diff} = 0.6$, $SE_{diff} = 0.2$) than with friends (TFT: $M = 6.3$; $SE = 0.1$; Selfish: $M = 5.1$; $SE = 0.1$; $M_{diff} = 1.2$, $SE_{diff} = 0.2$). As with the morality trait impressions, the reported likeability of the participant's partner appeared to be impacted more when that partner was a friend who behaved in a self-interested manner than when that partner was a stranger who did so.

Using Interactive Round Performance to Predicting Trait Impressions.—Zero-order correlations demonstrated that interactive round cooperation was positively associated with impressions of morality, $r = .313$ ($p < .001$), and global positivity, $r = .345$ ($p < .001$), but was unrelated to competence, $r = .103$ ($p = .088$). When entered as a covariate into the above ANOVAs performed on impression scores for morality, competence, and global positivity, interactive round cooperation was a significant covariate for morality, $F(1, 257) = 4.77$, $p = .030$, η_p^2 = .018, and for global positivity, $F(1, 258) = 10.46$, $p = .001$, η_p^2 = .039. However, the interactive round cooperation eliminated only the partner type × social distance interaction for global positivity. This suggests that the disproportionately higher global positivity ratings that participants provided for the Tit-for-Tat friend over the Selfish

friend relative to the Tit-for-Tat stranger over the Selfish stranger were linked to the experience that the participant had with the friend who reciprocated cooperation. The non-significant correlation between cooperation and competence impressions suggests that, in the context of the current iterated PD game, participants are less likely to link their beliefs about the other person's intelligence to the behaviors displayed during the interactive round.

Discussion

The current study examined younger and older adults' interactions with others in the context of an iterated PD game. As predicted, younger and older adults cooperated more with friends than with strangers, and friends were viewed as more moral and competent than strangers. These findings are consistent with past research on cooperation in economic games (Majolo et al., 2006; Segal & Sobel, 2007), and extend this work by demonstrating that older and younger adults display similar differences in their willingness to cooperate with others as a function of the nature of relationships. Younger and older adults both cooperated less with selfish partners over time, suggesting that, although older adults prefer passive forms of emotion regulation in interpersonal conflict (Birditt & Fingerman, 2005; Blanchard-Fields, 2007), they also behave assertively in social situations that evoke anger or annoyance (Blanchard-Fields & Coats, 2008). Selfish treatment was enough to trigger retaliation by both younger and older adults.

Despite the similarities in younger and older adults' behaviors, a number of important differences emerged. When interacting with selfish partners, older adults displayed more cooperation and, when taken advantage of, displayed a greater tendency toward conciliatory behavior than did younger adults. Despite younger adults' superior performance in the alone round, younger adults were more likely than older adults to block rewards to the other player in the interactive round, especially when faced with a selfish partner. Older adults retaliated as well, but did so less and left the door open for cooperation. This is consistent with findings showing that aging is associated with increased trust in others (Li & Fung, 2013), even in the face of minor transgressions (Bailey, Petridis, McLennan, Ruffman, & Rendell, 2019). Furthermore, older adults attributed greater morality to the other player than did younger adults, suggesting that they did, in fact, trust the other player more than did younger adults.

It is tempting to attribute older adults' cooperative tendencies to age-related cognitive deficits (e.g., Milinski & Wedekind, 1998) and a susceptibility to being taken advantage of, but it is important to consider what such cooperative behavior means in the context of the interaction. Players seek mutual interest to maximize reward, giving up short-term gain or one-upmanship. By cooperating more with selfish partners and by retaliating for fewer turns after a defection, older adults appear to have worked harder than younger adults to restore trust and mutual cooperation, or "faith" (Luce & Raifa, 1957). This is consistent with past work showing that older adults are more forgiving than younger adults (Cheng & Yim, 2008; Steiner, Allemand, & McCullough, 2011), that older adults balance generosity with fairness (Bailey, Ruffman, & Rendell, 2013), and that older adults are more careful to balance direct action with passive, self-directed emotion regulation strategies in the face of conflict (Blanchard-Fields, Mienaltowski, & Seay, 2007).

Moreover, recent studies have also demonstrated that advancing age is associated with more prosocial behavior and less self-reported relational satisfaction when exploitative behavior is used as a means to attain financial reward (Matsumoto et al., 2016). Past research on economic games including the PD suggests that a willingness to forgo retaliation when extorted by a partner is an evolutionary adaptive way to restore cooperation (Axelrod, 1980; Press & Dyson, 2012) and can lead to sophisticated behavioral combinations that work to tune the partner's behavior toward the benefit of the player (Nowak & Sigmund, 1993; Szolnoki & Szabó, 2007). Older adults' leniency (Bailey et al., 2019) and generosity toward others may stem from ego transcendence that accompanies advancing age (Pornpattananangkul, Chowdhury, Feng, & Yu, 2019). Older adults' reduced motivation to manipulate others through conflict (Matsumoto et al., 2016) is consistent with the predictions made by socioemotional selectivity theory that age differences in everyday goals support contributions to long-term social beneficence in older adulthood despite possible short-term personal costs (Carstensen, 2006). Future research is needed to determine the extent to which older adults' willingness to acquiesce during conflict poses actual costs to their well-being or finances in everyday situations. Additionally, future research should examine the extent to which older adults' strategic forgiveness within iterated economic games is intentional and meant to be part of a larger goal to seek long-term benefits.

In the current study, both younger and older adults (a) provided lower impressions of morality for the selfish partner than the tit-for-tat partner, and (b) calibrated their impressions based on the experiences that they had during the interaction. However, older adults offered higher morality ratings for selfish partners than did younger adults, despite having experienced marginally ($p \sim .07$) more obstacles to success in the game at the hands of that partner. One possible explanation for this is that older adults' judgments of the other player were impacted by the perceived success they achieved in re-establishing cooperation after displaying conciliatory behaviors toward their partner. In other words, the success that the older adults had at working toward socioemotional goals within the game may have influenced their impressions of their partner (Hess & Kotter-Grühn, 2011). Impressions of morality were positively associated with cooperation during the game, so, when older adults' conciliatory behaviors were actually met with cooperation, they benefited from that cooperation and possibly observed the selfish partner in a more favorable light. Future research might examine participants' memory for transgressions during the iterated PD to determine if older adults attend to their occurrence and possibly weigh evaluations of gaming partners by accessing this information. The findings from the current study are consistent with those from a recent study in which self-interested behavior displayed by an imagined interaction partner led to greater decline in partner-rated trustworthiness for younger adults than for older adults (Bailey et al., 2019).

Interestingly, the social distance manipulation did not differentially impact the behaviors of younger and older adults during the experiment. Past research has linked negative social exchanges with increased negative affect in older adults (Newsom, Nishishiba, Morgan, & Rook, 2003). Members of both age groups cooperated more with friends than with strangers, and were harsher in evaluating their friends when friends were less willing to reciprocate cooperation during the game. The correlation between global positivity and cooperation during the game provides some support for the conclusion that, like in everyday interactions,

exchanges that are less prosocial than one might have hoped for can affect how we feel about our partner. Given that the iterated PD task constrains participants' interaction to simply making choices within the game, relationship-supportive behaviors that might be more commonly displayed by older adults (e.g., communicated shared goals, attempts to offer emotional support, purposefully avoidant behavior) or socially aggressive behaviors more commonly displayed by younger adults (e.g., confrontation) in response to conflict within one's social network could not emerge between the gaming partners and alter the trajectory of the interaction (Fingerman & Charles, 2010). Although the older participants reported longer relationships with their friends than did the younger adults, there were no age differences in relationship quality, and participants from each age group were equally likely to attend the experimental session with someone whom they nominated to be their best or closest friend. In the future, manipulating social distance across more levels than friend and stranger could identify if age differences emerge in behavioral reactions to self-interested choices by others who share a weaker relationship with the participant (Jones & Rachlin, 2006; Pornpattananangkul et al.,2019).

Limitations

Although this study extends prior research, it is not without its limitations. First, the objective of the game was to earn as much reward as possible, and behaviors that violated this objective in the context of mutual partner interest were assumed to reflect conflict. However, conflict emerging in game is less personally impactful than conflict that occurs in everyday relationships. That said, the iterated PD game serves as a useful technique for evaluating conflict because it affords control over the knowledge held about the other player, the behaviors that participants are free to display, and the potential for risking a disagreement between partners that could have an enduring effect on a relationship. Second, participants interacted with partners whom they believed to be similar in age. Given that people are generally more lenient toward older adults than toward younger adults who commit a transgression (Miller, Charles, & Fingerman, 2009), the potential confound posed by the older adults' perception of their partners' age cannot be escaped. Third, this study utilizes a cross-sectional, extreme age groups design, so findings are assumed to reflect changes that take place due to aging, but cohort and time of measurement effects cannot be ruled out. Additionally, the age range for the older adult sample was rather broad (mid-50s to early 80s), so age-related differences may be underestimated in the current study. Fourth, social distance was conceptualized in this study via the comparison of interactions between strangers and those of friends, and limits were not placed on the length or the closeness of the friendship of those in the Friends condition given the challenges associated with recruiting and scheduling pairs of participants. Future research may opt for alternate definitions of social distance (e.g., forms of genetic relatedness or closest social other) or to place additional restrictions on relationship length to more precisely evaluate the potential for social distance to moderate age-related differences in iterated PD performance. Despite these issues, this study adds unique value to the field because it provides evidence that older adults are more likely than younger adults to balance direct action with emotional restraint in the context of a real-time interpersonal conflict within an economic game commonly used to understand conflict resolution.

Conclusions

Despite an abundance of research demonstrating age differences in strategies that are used to solve hypothetical interpersonal problems, the current study is one of the few that track how younger and older adults' behaviors evolve during an actual, non-hypothetical, conflict. It may be the first to report on younger and older adults' interactions with friends and strangers through an iterated prisoner's dilemma game. Although younger and older adults both retaliate when faced with conflict created by a selfish partner, older adults tend to be more forgiving. They consequently may view their partner in a more favorable light when reconciled. This study adds to the growing body of research on age differences in economic games and highlights that, in social contexts, older adults' more nuanced behaviors relative to younger adults may confer both costs and benefits. When older adults give a selfish partner a second chance, they open themselves up to being taken advantage of. However, by doing this, older adults may re-establish trust and mend a tarnished relationship.

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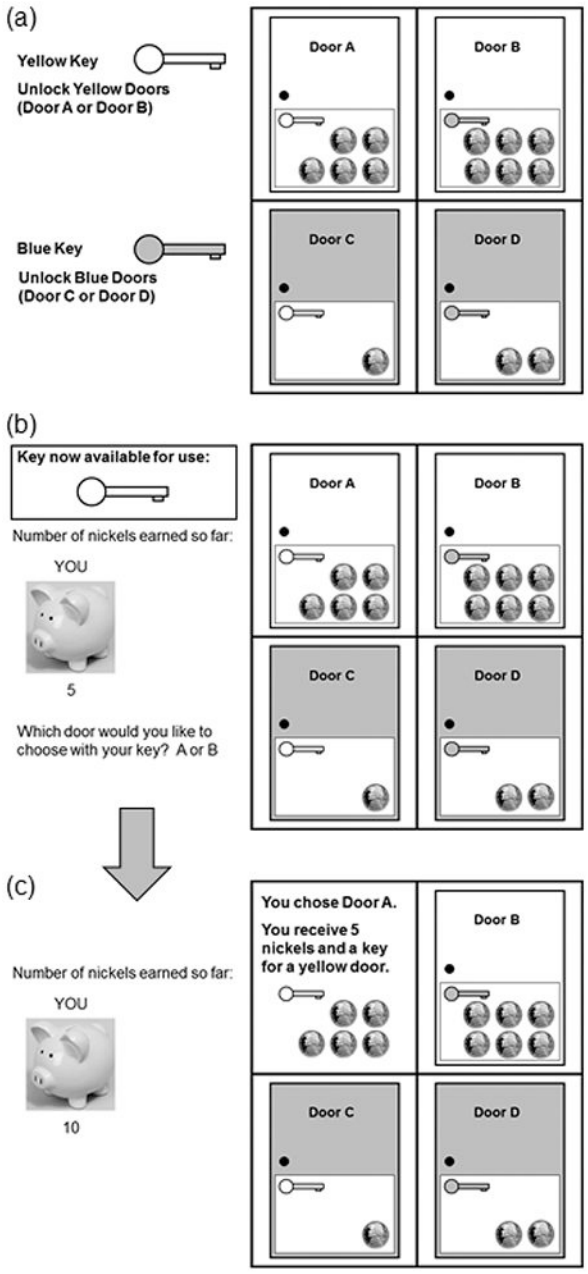

Figure 1.

Illustration of the game environment for the iterated prisoner's dilemma and a turn in the Alone Round. (a) On each turn, a person selects one door using the available key. Yellow (white shading) keys open yellow doors, and blue (gray shading) keys open blue doors. (b) If the participant has yellow key in the Alone Round, s/he can choose to open either Door A or Door B. (c) Participant chose to open Door A, so the nickel total was updated to reflect this choice and a reminder is provided for the key that is available for their next turn.

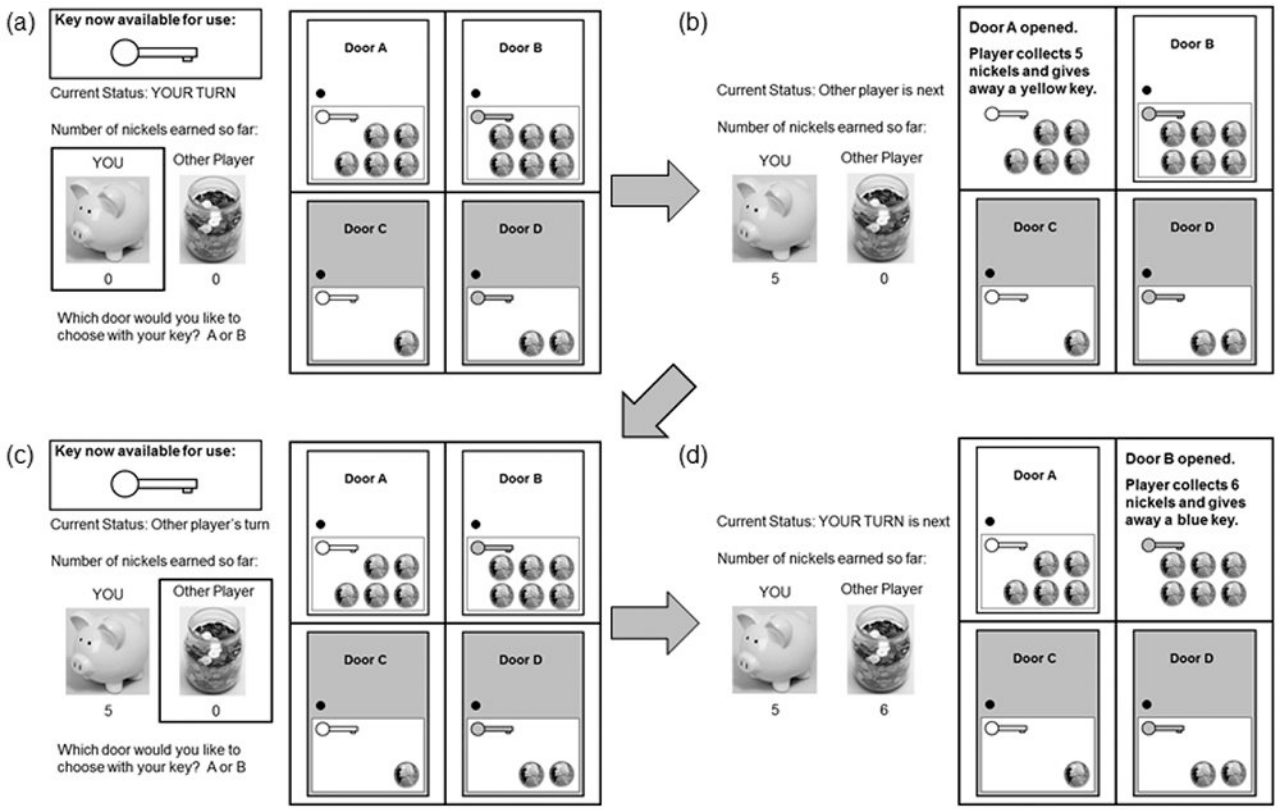

Figure 2.

Illustration of turn taking within the Interactive Round. (a) The participant has a yellow key and can choose either Door A or Door B. (b) Door A is selected. The participant receives 5 nickels and passes the yellow key to the other player. (c) The other player has a yellow key and can choose either Door A or Door B. (d) Door B is selected. The other player receives 6 nickels and passes the blue key to the participant.

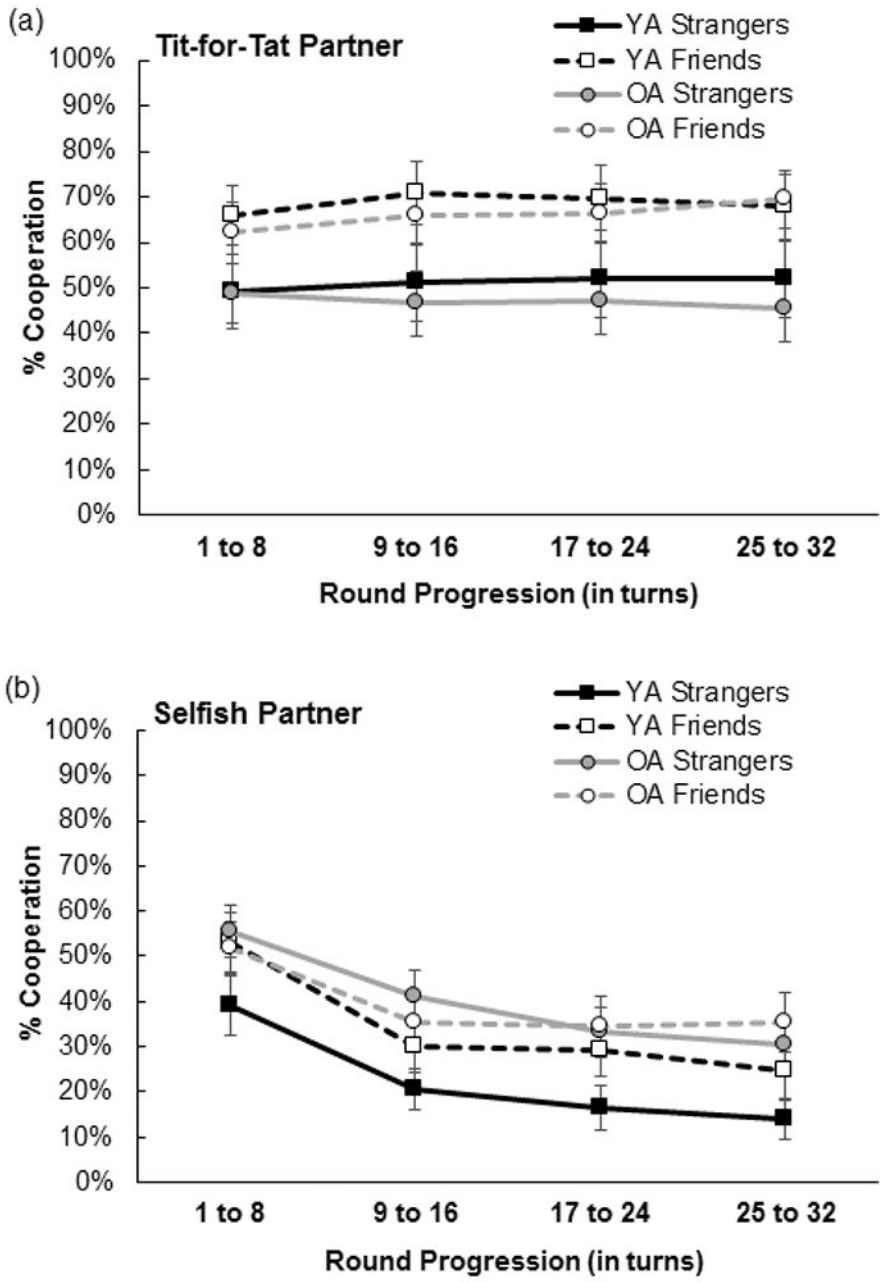

Figure 3.

Cooperation in the Interactive Round displayed by younger and older adults for friends and for strangers (a) when interacting with the Tit-for-Tat partner, and (b) when interacting with the Selfish partner. Means reflect the average performance in 8-turn segments. Error bars reflect ±1 SE.

Table 1.

Sample demographics.

Factor	Younger Adults Mean (SD)	Older Adults Mean (SD)	Age Group Comparison
Age	19.7 (1.5) years	69.5 (5.8) years	-
Inductive Reasoning	23.6 (3.2)	17.0 (5.3)	$t(279) = 12.97$, $p < .001$, d = 1.55
Verbal Ability	16.6 (5.1)	22.0 (7.6)	$t(278) = 7.05$, $p < .001$, $d = 0.85$
Processing Speed	67.3 (10.8)	45.4 (9.3)	$t(279) = 18.11$, $p < .001$, $d = 2.17$

Table 2.

Number of participants in each condition of Interactive Round of the iterated Prisoner's Dilemma.

		Stranger	Friend
Younger Adults	Tit-for-Tat	33	38
	Selfish	38	38
Older Adults	Tit-for-Tat	33	36
	Selfish	32	35