Understanding Human Cooperation

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2016

document version
Publisher's PDF, also known as Version of record

Chapter 6

Life History Strategy and Human Cooperation

This chapter is based on Wu, J., Balliet, D., Tybur, J. M., Arai, S., Van Lange, P. A. M., & Yamagishi, T. (2016). *Life history strategy and human cooperation.* Manuscript submitted for publication.

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Abstract

Across five studies using samples from both Japan and United States (N = 2,345), we take a multi-method approach to test the prediction from life history theory that a slow, compared to fast, life history strategy promotes investment in cooperative relationships. Studies 6.1 and 6.2 examined how different life history strategy measures (i.e., Mini-K and High-K Strategy Scale) relate to cooperation in various economic games. Studies 6.3 to 6.5 measured early childhood environments (i.e., childhood harshness and unpredictability), manipulated resource scarcity using previously validated methods, and then measured cooperation. Across our studies, we also examined four hypothesized psychological mechanisms that could explain the relation between life history strategy and cooperation: temporal discounting, concern for reputation, social value orientation, and trust in others. Overall, we found no support for the hypothesis that life history strategy predicts cooperation or that early childhood environments interact with current resource scarcity to predict cooperation. Thus, our initial findings imply that life history theory does not account for individual variation in cooperation with unknown others.

Keywords: life history strategy, resource scarcity, harshness, unpredictability, cooperation

All organisms encounter situations that require strategic decisions regarding how to allocate finite resources across competing, fitness-relevant activities. Such resource allocation trade-offs form the foundation of life history theory, which provides a theoretical framework to understand how, when, and why individuals make fitness trade-offs (Del Giudice, Gangestad, & Kaplan, 2015; Hill, 1993). Optimal trade-off strategies shape the expression of a variety of behaviors, including those relevant to mating, risk taking, and aggression (Del Giudice, 2014; Figueredo et al., 2006; Hill, Ross, & Low, 1997).

Social interactions similarly involve resource allocation trade-offs, in particular between investing in oneself versus a relationship or group. In such social dilemmas, individuals benefit from behaving selfishly and maximizing their own immediate interest, whereas groups benefit from cooperation (Van Lange, Joireman, Parks, & Van Dijk, 2013). Thus, decisions to cooperate (or not cooperate) with others have important consequences for individuals, relationships, and groups. Previous theorizing suggests that the expressions of different life history (LH) strategies in humans may extend to social behaviors, such as long-term cooperation and reciprocity (Del Giudice, 2014; Del Giudice et al.,

2015). However, no research has directly tested this prediction.

The present research uses both correlational and experimental approaches to test how LH strategy affects behavior in situations with conflict of interest between self and others. Our first aim was to test whether faster or slower LH strategy relates to more cooperative decisions in social interactions. Our second aim was to test the proximate psychological mechanisms that could account for this relation (i.e., temporal discounting, concern for reputation, social value orientation, and trust in others).

The Origin and Development of Life History (LH) Strategy

Resource allocation trade-offs force individuals to prioritize one activity over the other. One key trade-off concerns dividing resources to *somatic effort* (e.g., growth, maintenance, and learning) versus *reproductive effort* (e.g., finding and attracting mates). For example, resources invested in immune function can be diverted from resources used to attract a mate. The allocation decisions in response to these fitness trade-offs shape one's LH strategy, which varies on a fast-to-slow continuum (Del Giudice et al., 2015). Those adopting faster strategies tend to prioritize earlier fitness returns (e.g., through faster development and earlier reproduction). They mature and begin reproduction earlier, have more children, and invest less in individual child. Conversely, those following slower strategies prioritize later fitness returns. They reach sexual maturation later, invest more in embodied capital, begin reproduction at an older age, and have fewer children in whom they invest heavily (Del Giudice et al., 2015; Ellis, Figueredo, Brumbach, & Schlomer, 2009).

Given that LH strategies to maximize fitness vary across ecological conditions (Ellis et al., 2009), natural selection can favor developmental systems that use early life experiences to calibrate later strategies. Two important features of an environment are harshness (i.e., morbidity-mortality rates caused by uncontrollable factors) and unpredictability (i.e., temporal variation in harshness) (Frankenhuis, Panchanathan, & Nettle, 2016). Harsh and unpredictable early-life environments (e.g., resource-scarce or dangerous environments) sensitize individuals to follow faster LH strategies (Belsky, Schlomer, & Ellis, 2012; Ellis et al., 2009). For example, individuals exposed to more unpredictable and rapidly changing environments in their early childhood (i.e., age 0-5) tend to have more sexual partners and engage in more risky behaviors at age 23 (Simpson, Griskevicius, Kuo, Sung, & Collins, 2012). A variety of life history parameters—such as sexual, reproductive, parental, familial, and social behaviors—are putatively captured by a single common factor (i.e., K-Factor; Figueredo et al., 2005). People following slower (i.e., high-K) strategies tend to have fewer offspring, invest more in those offspring, be more committed to long-term relationships, and care more about long-term benefits relative to short-term gains (Figueredo et al., 2005, 2006; Giosan, 2006). Moreover, factors such as one's vulnerability to lifespan-shortening diseases can make people switch toward a faster (i.e., low-K) LH strategy (Hill, Boehm, & Prokosch, 2016).

Importantly, the effects of early-life environments are magnified under specific environmental circumstances. That is, behavioral traits related to faster or slower LH strategies are responsive to immediate stress (e.g., resource scarcity, mortality risk) in the current environment. For example, research suggests that people from harsher childhood environments are more impulsive and risk-taking (i.e., traits related to faster strategy) when they detect cues of mortality risk or resource scarcity (Griskevicius et al., 2013; Griskevicius, Tybur, Delton, & Robertson, 2011).

Life History (LH) Strategy and Cooperation

In social interactions, selfish and exploitative behaviors benefit oneself in the short term through immediate gains of resources, but they involve potential long-term costs, such as reputational damage and ostracism. In contrast, cooperation requires forgoing immediate gains, but facilitates one to acquire long-term indirect benefits via a cooperative reputation (Nowak & Sigmund, 2005). Individuals following fast versus slow LH strategies might resolve this tradeoff differently (Del Giudice, 2014; Figueredo et al., 2005; Hill et al., 2016). Given that a faster LH strategy relates to greater discounting of delayed reward, more risk taking behavior (Griskevicius et al., 2011), and more impulsivity (Mittal & Griskevicius, 2014), individuals following faster strategies might resolve the aforementioned trade-off in social dilemmas by behaving relatively more selfishly. Some recent evidence is consistent with this proposition: Individuals exposed to harsh and unstable environment (e.g., family neglect, conflict and violence) during childhood are more likely to exploit cooperative partners and retaliate against others' defections (McCullough, Pedersen, Schroder, Tabak, & Carver, 2013). Moreover, people from deprived (vs. affluent) neighborhoods with a tendency to follow faster strategies allocate less to others in dictator games, and they spoil public goods more (e.g., through littering; Nettle, Colléony, & Cockerill, 2011). Despite initial support for a relationship between LH strategy and cooperation, existing evidence is limited in two ways: First, it did not directly test how life history parameters (e.g., the K-Factor) relate to cooperation or whether early-life environments interact with current stress (e.g., resource scarcity) to predict cooperation. This research would use multiple methods to test the prediction that a slower, compared to a faster, LH strategy promotes more cooperation (*Hypothesis 1*). Second, the proximate psychological mechanisms that explain this relation have received less attention and are still unclear.

The Proximate Mechanisms Underlying Life History (LH) Strategy and Cooperation

Some evidence suggests that the tendency to value future rewards over short-term benefits (e.g., temporal discounting, time preference, delay of gratification)—a signature of a slow LH strategy (Griskevicius et al., 2011)—can predict cooperation. For example, consideration of future consequences relates to increased pro-environmental behavior (Joireman, Lasane, Bennett, Richards, & Solaimani, 2001), and reduced intergroup competition (Wolf

et al., 2009). People who devalue future rewards tend to cooperate less frequently (Harris, & Madden, 2002), and people with lower discount rates tend to contribute more to public goods (Curry, Price, & Price, 2008). Other research demonstrates that present and future orientations mediate the relation between developmental environments and behavioral strategies of aggression or resource exploitation (Kruger, Reischl, & Zimmerman, 2008). Thus, we predict that people with slower, compared to faster, LH strategy value future reward more and have lower discount rates (*Hypothesis 2a*), and that this temporal discounting mediates the relation between LH strategy and cooperation (*Hypothesis 2b*).

People with different LH strategies—those who tend to vary in their tendencies to value immediate versus future reward—may display different reputation management strategies. Both theory and empirical evidence imply that people with good reputations are more likely to be chosen as coalition partners and to receive delayed indirect benefits from third parties within groups and social networks (Nowak & Sigmund, 2005; Sylwester & Roberts, 2010). Thus, people who value the future may care more about their reputation and future indirect benefits or costs, and thus be more cooperative (Barcaly, 2012; Del Giudice et al., 2015). Indeed, reputational concerns facilitate cooperative behavior in both economic games and real-life situations (for recent reviews, see Milinski, 2016; Wu, Balliet, & Van Lange, 2016c). Thus, we predict that people with slower, compared to faster, LH strategy are more concerned about their reputation (*Hypothesis 3a*), and that concern for reputation mediates the relation between LH strategy and cooperation (*Hypothesis 3b*).

Individuals also vary on dispositional preferences in outcome distribution between self and others—a trait known as social value orientation (SVO; Van Lange, Otten, De Bruin, & Joireman, 1997). Other-regarding and prosocial (vs. self-regarding and proself) preferences are more costly for people following faster strategy due to harsh and unpredictable early-life environments. Hence, individuals following faster strategies might display more proself orientations (*Hypothesis 4a*). Further, given that SVO predicts cooperation in both economic games and real-life situations, such that prosocials are generally more cooperative than proselfs (Balliet, Parks, & Joireman, 2009; Van Lange, Agnew, Harinck, & Steemers, 1997), we predict that SVO mediates the relation between LH strategy and cooperation (*Hypothesis 4b*).

Additionally, people who tend to follow faster strategy due to harsh and unpredictable childhood environments may also be more vulnerable to others' noncooperation and exploitation, especially in resource-scarce situations. Thus, these individuals may develop less trust in others, which could prevent them from being taken advantage of by others. Importantly, trust predicts one's cooperation in situations with conflict of interests between self and others (Balliet & Van Lange, 2013). Thus, we predict that people with faster, compared to slower, LH strategies trust others less (*Hypothesis 5a*), and this trust in others mediates the relation between LH strategy and cooperation (*Hypothesis 5b*).

The Present Research

We conducted five studies using correlational and experimental methods to test our hypotheses (see Table 6.4). Studies 6.1 and 6.2 measured LH strategy with the Mini-K and High-K Strategy Scales (see also Patch & Figueredo, 2016), and observed cooperation in various economic games. Studies 6.3 through 6.5 measured early childhood environments (i.e., SES and unpredictability; Griskevicius et al., 2011), and manipulated resource scarcity using multiple validated methods from previous research. Specifically, resource scarcity was manipulated in Study 6.3 using pictures indicating resource scarcity (vs. resource abundance or control) (see Vaughn, Cronan, & Beavers, 2014), and Studies 6.4 and 6.5 employed different initial endowments in an economic game (see Krosch & Amodio, 2014). Study 6.5 also manipulated outcome interdependence using two economic games with different payoff structures. Across several studies, we measured psychological factors that were hypothesized to explain the relation between LH strategy and cooperation (i.e., temporal discounting, concern for reputation, SVO, and trust in others).

Study 6.1

Study 6.1 used a correlational approach to test whether LH strategy relates to cooperation using a non-student Japanese sample. We measured LH strategy with the Mini-K and High-K Strategy Scales, and cooperation with twelve economic games.

Method

Participants and design. Six hundred non-student residents in a suburban city of Tokyo were selected from about 1,670 applicants who responded to a flyer distributed to about 180,000 households. They were invited to participate in a large research project with eight waves. Five hundred sixty-three residents (290 women, M_{age} = 39.96 years, *SD* = 10.79) voluntarily participated in the initial wave that included demographic measures of age and sex. Other measures in this study were administered across different waves (*N*s = 483, 489, 473, 471, 470, 451, 424 from Wave 2 to 8).

Procedure and materials. Participants completed the *Mini-K* in Waves 4 and 7 (αs = .81 and .79), and the *High-K Strategy Scale* in Wave 6 (α = .88) to measure LH strategy. The Mini-K consisted of 20 items (e.g., "I often make plans in advance", "while growing up, I had a warm relationship with my biological mother") with a variety of indicators of slow LH strategy that were rated on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*) (Figueredo et al., 2006). Average score across these items constituted the K-Factor, and higher K indicated slower LH strategy (Patch & Figueredo, 2016). The High-K Strategy Scale (HKSS) originally consisted of 26 items that were rated on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*), except for item 19 (i.e., Are you married or cohabitating?) that was coded as 1(no) or 5(yes) (Giosan, 2006). Removing items that only apply to

married or partnered participants, we used the average score across the first 22 items to obtain HKSS score. As expected, the two Mini-K measures and HKSS were highly intercorrelated (*r*s > .54, *p*s < .001).

Across different waves, participants interacted with others in twelve economic games with thirteen cooperation measures, and their decisions had monetary consequences (e.g., Shinada, & Yamagishi, 2014; Yamagishi et al., 2012, 2013; Yamagishi, Li, Takagishi, Matsumoto, & Kiyonari, 2014; see Table 6.1).

Results and Discussion

The thirteen cooperation measures were highly intercorrelated (*p*s < .01, see Table 6.2). However, except for a small negative relationship between Mini-K (Wave 4) and cooperation in the ultimatum game, $r(451) = -.10$, $p = .03$, none of the two Mini-K measures or HKSS related to any cooperation measure (all *p*s > .05, see Table 6.2). These results suggest that LH strategy does not relate to cooperation in economic games.[1]

Study 6.2

Study 6.2 further tested the relation between LH strategy and cooperation using a non-student sample from the United States. We measured early-life environments, LH strategy (i.e., Mini-K), and cooperation in a dictator game (DG) and a prisoner's dilemma game (PDG).

Method

Participants and design. Participants were 508 US adults (306 women, $M_{age} = 35.84$ years, $SD = 12.15$) recruited from Amazon Mechanical Turk (MTurk). They completed the study for US$1.00. Twenty-one participants won an extra 2-dollar bonus based on their decisions during the study.

Procedure and materials. After providing informed consent, participants first completed measures of childhood unpredictability, childhood SES, and Mini-K (same items as Study 6.1, -3 = *strongly disagree*, +3 = *strongly agree*), then the random-ordered measures of temporal discounting, concern for reputation, SVO, and trust in others. Afterward, they

[1] Other measures relevant to the current research included (a) temporal discounting (Wave 4): 29 trails involving choices between a smaller immediate reward versus a larger delayed reward (Kirby, Petry, & Bickel, 1999); (b) SVO (Wave 5): six primary items of the SVO slider measure (Murphy, Ackermann, & Handgraaf, 2011); (b) general trust (Waves 1, 3, and 6): five items on a 7-point scale (e.g., "Most people are trustworthy"; 1= *strongly disagree*, 7 = *strongly agree*; Yamagishi & Yamagishi, 1994). Correlational analyses revealed that (a) temporal discounting (i.e., delay-discounting rates) did not significantly correlate with Mini-K(Wave 4), $r(470) = -.03$, $p = .57$, Mini-K(Wave 7), $r(434) = -.03$, $p = .49$, or HKSS, $r(449) = -.04$, $p = .40$, which did not support Hypothesis 2a; (b) SVO did not significantly correlate with Mini-K(Wave 4), $r(451) = .07$, $p = .15$, Mini-K(Wave 7), $r(436) = .09$, $p = .06$, or HKSS, $r(453) = .003$, $p = .95$, and so Hypothesis 4a was not supported;(c) general trust measures were significantly correlated with Mini-K(Wave 4), Mini-K(Wave 7), and HKSS (all *r*s > .24, *p*s < .001), which supported Hypothesis 5a.

Table 6.1
Cooperation Measures in Different Economic Games across Waves (Study 6.1)

Game paradigm	Cooperation measure and game description
Repeated one-shot prisoner's dilemma game (Wave 2)	PDG1: proportion of trials in which participants gave the endowment to their partner *Participants played (a) a simultaneous game, a sequential game as (b) a first player and (c) the second player, each with three stake sizes (JPY 300, 800, or 1,500). They decided whether to give their endowment to their partner or keep it across nine trials. The endowment was doubled if given to the other, but remained the same if kept for oneself.*
One-shot prisoner's dilemma game (Wave 4)	PDG2: proportion of endowment participants gave to their partner [a] *Participants were endowed with JPY 1,000 and decided simultaneously how much to give to their partner. Any amount given to the partner was doubled.*
One-shot dictator game (Wave 3)	DG1: proportion of endowment participants gave to the recipient [a] *Each participant was endowed with JPY 1,000 and decided to give any of these to the recipient.*
One-shot repeated dictator game (Wave 3)	DG2: average proportion of endowment participants gave to the recipient *Participants played this game with six recipients. The size of the endowment varied from JPY 300 to JPY 1,300 (i.e., 300, 400, 600, 700, 1,200, and 1,300). They made their decisions in increments of 10% as the allocator in each game.*
Faith game (Wave 3)	FG: proportion of endowment participants invested in their partner (i.e., the allocator in a previous DG) [a] *Participants (i.e., trustor) were matched with another participant who previously played a dictator game (DG) as an allocator. They learned that their partner had decided how much of JPY 1,000 to give to someone. Next, participants were given JPY 1,000 and decided how much to invest in their partner. The invested money was tripled and returned to participants according to the proportion that their partner had allocated to the recipient in the previous DG.*
1st and 2nd social dilemma game (Waves 4 and 8)	SDG1 and SDG2: proportion of endowment participants contributed to the group [a] *Each participant was endowed with JPY 1,000 and contributed any amount to a public good. Total contribution to the public good was doubled and equally divided among all group members.*

Trust game (Wave 5)	TGtrust: proportion of endowment participants sent to their partner as a trustor [a] TGreturn: average proportion of the tripled money they sent back as a trustee for all possible decisions of the trustor *Participants first acted as the trustor and sent some of JPY 1,000 to the trustee. The trustee received the tripled amount and sent any amount back to the trustor. The amount sent back remained the same value. Then participants indicated the amount they would send back to the trustor in increments of 10% of the tripled money for 10 possible decisions of the trustor (i.e., the trustor sent JPY 100 to JPY 1000 in increments of JPY 100).*
Ultimatum game (Wave 5)	UG: proportion of endowment participants offered to the responder as a proposer [a] *Participants (i.e., proposer) initially received JPY 1,500 and gave any amount to the responder, who decided whether to accept or reject this offer. If the responder accepted, the endowment was divided according to the proposed offer; If the responder rejected, both received nothing.*
Third-party punishment game (Wave 6)	TPPG: average proportion of endowment participants gave to the recipient as an allocator across the two TPPGs a *This game involved an allocator, a recipient, and an observer. The allocator initially received JPY 1,500 and gave any amount to the recipient. The recipient passively accept the amount they were given. Then the observer decided how much of JPY 375 (in increments of JPY 25) to spend to reduce the allocator's earnings. Any amount spent reduced four times of this amount from the allocator. This game was played twice during which the observer either had no punishment fund or a punishment fund of JPY 500.*
Impunity game (Wave 6)	IG: the proportion of endowment participants offered to the responder as a proposer a *Participants (i.e., proposer) were initially endowed with JPY 1,500 and decided how much to offer to the responder, who had to accept or reject this offer. If the responder accepted, the endowment was divided according to the proposed offer; If the responder rejected, the responder earned nothing, but the proposer still earned the amount kept for self.*
Stag hunt game (Wave 8)	SHG: participants' decision to invest (or not invest) in their partner *Two participants decided simultaneously whether to invest in their partner or not. If both invested, both earned JPY 1000; If only one invested, the one who invested earned nothing, whereas the other earned JPY 500; If neither invested, both earned JPY 500.*

Note. [a] Participants made their decisions in increments of JPY 100. For more detailed game descriptions, see Supplementary Materials.

Table 6.2
Intercorrelations, Means, and Standard Deviations of Life History Strategy Measures and Cooperation in Study 6.1

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mini-K1	4.14	0.69	–														
2. Mini-K2	4.23	0.63	.76*	–													
3. HKSS	3.32	0.58	.58*	.55*	–												
4. PDG1	.69	.30	-.03	-.01	-.06	–											
5. PDG2	.32	.32	-.01	.06	.02	.47*	–										
6. DG1	.33	.24	.03	.04	-.02	.43*	.42*	–									
7. DG2	.33	.21	.06	.09	.08	.50*	.53*	.71*	–								
8. FG	.41	.31	.04	.01	.06	.29*	.34*	.38*	.47*	–							
9. SDG1	.33	.31	-.02	.02	-.03	.44*	.69*	.42*	.48*	.32*	–						
10. SDG2	.36	.31	-.05	.01	.04	.45*	.59*	.41*	.47*	.28*	.65*	–					
11. TGtrust	.43	.33	-.01	.02	.02	.46*	.64*	.39*	.51*	.35*	.58*	.57*	–				
12. TGreturn	.28	.20	.01	.05	.03	.47*	.56*	.49*	.63*	.31*	.46*	.44*	.50*	–			
13. UG	.41	.15	-.10*	-.06	-.07	.31*	.40*	.36*	.47*	.20*	.38*	.33*	.40*	.43*	–		
14. TPPG	.30	.21	.02	.05	.06	.46*	.53*	.46*	.63*	.32*	.50*	.48*	.47*	.54*	.45*	–	
15. IG	.17	.21	.05	.07	.07	.36*	.51*	.41*	.52*	.27*	.43*	.37*	.38*	.50*	.37*	.57*	–
16. SHG	.76	.43	-.01	-.002	-.03	.37*	.36*	.19*	.26*	.14*	.31*	.35*	.34*	.25*	.22*	.30*	.21*

Note. Mini-K1/2 = Mini-K (Wave 4)/(Wave 7). Variables numbered 4 to 16 represent cooperation in two prisoner's dilemma games (PDG1 and PDG2), two dictator games (DG1 and DG2), the faith game (FG), two social dilemma games (SDG1 and SDG2), the trust game (TGtrust and TGreturn), the ultimatum game (UG), the third-party punishment game (TPPG), the impunity game (IG), and the stag hunt game (SHG). * $p < .05$.

completed two decision making tasks, during which they earned points (each point worth a 0.02% chance to win a 2-dollar bonus)[2]: (a) a dictator game (DG; Forsythe, Horowitz, Savin, & Sefton, 1994), in which participants were the allocator and freely divided 100 points between themselves and an "ostensible" recipient online (i.e., Person X); (b) a prisoner's dilemma game (PDG; Van Lange & Kuhlman, 1994), in which participants and their "ostensible" interaction partner (i.e., Person Y) were each initially endowed with 100 points, and each decided simultaneously to give any point to the other, who would receive the doubled amount. The points kept for oneself remained the same value. The number of points participants gave to their partner in each game was the measure of cooperation. Finally, participants reported their age and sex, learned about their partner's decision (i.e., 50 points, pre-programmed) in the PDG and their total earnings (range: 100 to 300 points) based on their decisions across two games, and were debriefed.

Childhood unpredictability. We used two measures of childhood unpredictability from earlier work on childhood environments and LH strategy: (a) three items ($\alpha = .65$; e.g., "In your early childhood, did your parents or legal guardians change jobs or occupational status?") on a 5-point scale (1 = *never*, 5 = *many times*; Szepsenwol, Simpson, & Griskevicius, 2015), and (b) three items ($\alpha = .84$; e.g., "When I was younger than 10, things were often chaotic in my house.") on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*, Mittal, Griskevicius, Simpson, Sung, & Young, 2015). The average scores for the two measures were highly correlated, $r(506) = .58$, $p < .001$. Thus, we standardized the average scores and calculated the mean of the two z-scores as the index of childhood unpredictability.

Childhood SES. Participants rated three items from previous research ($\alpha = .83$; e.g., "My family usually had enough money when I was growing up") on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*; Griskevicius et al., 2011). Higher average scores mean higher childhood SES.

Temporal discounting. Participants completed a randomized 20-item measure of temporal discounting (see Griskevicius et al., 2013). For each item, they chose between an immediate smaller reward the next day (from $9 to $86) and a delayed larger reward in 33 days (from $47 to $89). The number of delayed rewards chosen was the index of temporal discounting ($\alpha = .91$).

Concern for reputation. Participants rated seven items from previous research ($\alpha = .86$; e.g., "If my reputation is not good, I feel very bad") on a 5-point scale (1= *absolutely disagree*, 5 = *absolutely agree*; De Cremer & Tyler, 2005). Higher average scores mean more concern for reputation.

Social value orientation (SVO). Participants competed six primary items of SVO Slider Measure (Murphy et al., 2011). For each item, they chose their preferred mon-

[2] Participants also rated a 16-item prosociality measure (e.g., sharing, helping, taking care of others, and empathic feelings toward others' needs) (Caprara, Steca, Zelli, & Capanna, 2005). Some items overlapped with the Mini-K measure, so we did not report results for this measure.

etary allocation between themselves and an anonymous person. Based on their choices, we calculated a continuous index of SVO (i.e., SVO°). Higher scores mean more prosocial orientation.

Trust in others. Participants rated their agreement with three items (α = .64; e.g., "I completely trust most other people") on a 7-point scale (1 = *completely disagree*, 7 = *completely agree*; Van Lange, Vinkhuyzen, & Posthuma, 2014).[3] Higher average scores mean more trust in others.

Results and Discussion

The significant correlations between Mini-K and childhood unpredictability, $r(506) = -.17$, $p < .001$, and childhood SES, $r(506) = .24$, $p < .001$, offered convergent validity for the three measures as reflecting LH strategy. However, higher K did not relate to more cooperation in either the DG, $r(506) = .08$, $p = .06$, or the PDG, $r(506) = .04$, $p = .42$ (see Table 6.3). Thus, consistent with Study 6.1, these findings also suggest no direct relation between LH strategy and cooperation.

Further correlational analyses on Mini-K and other measures suggested that higher K (i.e., slower) strategy related to more concern for reputation, $r(506) = .20$, $p < .001$, more prosocial orientation toward others, $r(506) = .10$, $p = .02$, and more trust in others, $r(506) = .25$, $p < .001$. However, opposite to our prediction, Mini-K was negatively correlated with temporal discounting, $r(506) = -.10$, $p = .02$, such that higher K (i.e., slower) strategy relates to less preference in delayed rewards.

Cooperation in the DG was negatively correlated with temporal discounting, $r(506) = -.10$, $p = .03$, but positively correlated with concern for reputation, $r(506) = .16$, $p < .001$, SVO, $r(506) = .44$, $p < .001$, and trust in others, $r(506) = .12$, $p = .005$. Cooperation in the PDG was only positively correlated with SVO, $r(506) = .31$, $p < .001$, and trust in others, $r(506) = .10$, $p = .02$ (see Table 6.3).

Researchers suggest that significant indirect effects (i.e., mediation) can occur in the absence of significant total or direct effects of the independent variable on the dependent variable (Rucker, Preacher, Tormala, & Petty, 2011). Thus, LH strategy might affect cooperation indirectly through some of the proposed mediators, in the absence of its direct relation with cooperation. We further tested the mediation hypotheses using bootstrapping method for multiple mediation based on 5,000 bootstrap samples (Preacher & Hayes, 2008). We found that (a) the indirect effect of Mini-K on cooperation in the DG was significant through temporal discounting, $b = 0.25$, 95% CI [0.03, 0.67], concern for reputation, $b = 0.57$, 95% CI [0.17, 1.15], SVO, $b = 1.10$, 95% CI [0.08, 2.20], and trust in others, $b = 0.53$, 95% CI [0.01, 1.17]; (b) the indirect effect of Mini-K on cooperation in the PDG was only significant through SVO, $b = 1.09$, 95% CI [0.09, 2.33]. These results

[3] Participants also rated three items (α = .57; e.g., "I believe that most other people trust me") that measures trust in self (i.e., one's beliefs regarding other people's trust in self). Because this concept was not related to our research questions, we did not report results for this measure.

Table 6.3
Intercorrelations, Means, and Standard Deviations of the Measures in Study 6.2

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Childhood unpredictability	0.00	0.89	–							
2. Childhood SES	3.47	1.44	-.32*	–						
3. Mini-K	0.96	0.84	-.17*	.24*	–					
4. Temporal discounting	11.81	4.49	.04	-.09	-.10*	–				
5. Trust in others	3.17	1.25	-.05	.08	.25*	-.01	–			
6. Concern for reputation	3.44	0.78	-.03	.07	.20*	.06	.06	–		
7. SVO	27.92	13.19	.01	-.10*	.10*	-.02	.09*	.12*	–	
8. Cooperation in the DG	38.67	22.13	.03	-.04	.08	-.10*	.12*	.16*	.44*	–
9. Cooperation in the PDG	51.38	30.76	.05	-.04	.04	.05	.10*	.08	.31*	.44*

Note. $N = 508$, * $p < .05$, DG = dictator game, PDG = prisoner's dilemma game.

provided some support for Hypothesis 3b, 4b, and 5b that concern for reputation, SVO, and trust in others partly explained the relation between LH strategy and cooperation. However, the results on temporal discounting were opposite to, and did not support Hypothesis 2a or 2b.

Study 6.3

Study 6.3 further tested Hypothesis 1 that a slower, compared to faster, LH strategy would promote greater cooperation. Here, we operationalized LH strategy as the magnifying effect of early-life environments contingent on current environmental harshness (i.e., resource scarcity) (see Griskevicius et al., 2013), and tested their interaction in predicting cooperation. We also tested Hypothesis 2a and 2b on the mediation of temporal discounting.

Method

Participants and design. Participants were 456 US adults (277 women, M_{age} = 36.10 years, *SD* = 12.47) recruited from MTurk. They completed the study for US$0.80. Thirteen participants won an extra 2-dollar bonus based on their decisions. Participants were randomly assigned to one of three conditions (i.e., resource scarcity, resource abundance, and control).

Procedure and materials. After providing informed consent, participants completed several ostensibly unrelated tasks from different studies (i.e., visual recognition and memory, outcome preference, and decision making). They first viewed a 1-min slideshow of pictures about a "news story" that indicated *resource scarcity* (e.g., empty wallet) or *resource abundance* (e.g., full wallet), or did not see a slideshow (*control*). This method has been used in prior research to manipulate perceptions of resource scarcity (Vaughn et al., 2014, see also Rodeheffer, Hill, & Lord, 2012; Hill, Rodeheffer, Griskevicius, Durante, & White, 2012). Then, for "memory decay", they completed an outcome preference task that was the 20-item temporal discounting measure as in Study 6.1. The number of delayed rewards they chose was the index of temporal discounting (α = .92). Afterward, they were asked to recall as many pictures as possible and describe the "news story". Next, participants completed a decision making task (i.e., a dictator game) in which they were randomly assigned to be an allocator. They could freely divide 10 points (each worth a chance to win a 2-dollar bonus) between themselves and a recipient (Forsythe et al., 1994). The number of points they gave to their partner was the measure of cooperation (range: 0 to 10).

After their decision, we assessed their perceived childhood SES (α = .87, three items, same as Study 6.1) and current SES (α = .91, three items; e.g., "I have enough money to buy things I want") using measures from previous research on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*; Griskevicius et al., 2011). Participants' childhood SES (*M* =

3.60, *SD* = 1.60) and current SES (*M* = 3.57, *SD* = 1.70) were modestly correlated, *r*(454) = .33. Finally, participants reported their age and sex, and were debriefed. One suspicion check question suggested that they did not realize the real purpose of the study.

Results and Discussion

Cooperation. To test our hypotheses, we dummy coded resource scarcity into two contrast variables (*scarcity-versus-abundance* contrast and *scarcity-versus-control* contrast) and performed a hierarchical regression analysis on cooperation. Childhood SES was centered prior to analysis (Aiken & West, 1991). We entered the two contrasts (step 1), childhood SES (step 2), and the interactions between childhood SES and the two contrasts (step 3) as predictors. We found no significant effect of scarcity-versus-abundance contrast, β = .08, *t*(453) = 1.46, *p* = .15, scarcity-versus-control contrast, β = .03, *t*(453) = 0.56, *p* = .58, or childhood SES, β = -.003, *t*(452) = -0.07, *p* = .94. Childhood SES did not interact with scarcity-versus-abundance contrast, β = .02, *t*(450) = 0.34, *p* = .74, or scarcity-versus-control contrast, β = -.03, *t*(450) = -0.42, *p* = .68, to predict cooperation. An alternative hierarchical regression analysis on cooperation including childhood SES, current SES (step 2), and their interactions with the two contrasts (step 3) revealed the same results: no significant effects of the two contrasts, childhood SES, or interactions between childhood SES and two contrasts (*p*s > .14). Thus, we found no support for Hypothesis 1 (i.e., slower LH strategy relates to more cooperation).

Temporal discounting. The same hierarchical regression analysis on temporal discounting revealed no significant scarcity-versus-abundance contrast, β = .03, *t*(453) = 0.58, *p* = .56, scarcity-versus-control contrast, β = -.08, *t*(453) = -1.46, *p* = .15, or childhood SES, β = -.05, *t*(452) = -1.11, *p* = .27. Childhood SES did not interact with scarcity-versus-abundance contrast, β = .01, *t*(450) = 0.21, *p* = .84, or scarcity-versus-control contrast, β = .01, *t*(450) = 0.21, *p* = .84, to predict temporal discounting. An alternative hierarchical regression analysis on temporal discounting including childhood SES, current SES (step 2), and their interactions with the two contrasts (step 3) revealed the same results: no significant effects of the two contrasts, childhood SES, or their interactions (*p*s > .08). The non-significant interactions lend no support for Hypothesis 2a (i.e., slower LH strategy relates to less discounting of future rewards) or Hypothesis 2b (i.e., temporal discounting mediates the relation between LH strategy and cooperation).

Study 6.4

Study 6.4 conceptually replicated Study 6.3 using a different manipulation of resource scarcity, and further tested whether people following slower strategy are more prosocially orientated (*Hypothesis 4a*), and whether SVO mediates the relation between LH strategy and cooperation (*Hypothesis 4b*).

Method

Participants and design. Participants were 302 US adults (169 women, M_{age} = 35.90 years, *SD* = 11.54) recruited from MTurk. They completed the study for US$0.80. Nine participants won an extra 2-dollar bonus based on their decisions. Participants were randomly assigned to either the resource scarcity condition or the control condition.

Procedure and materials. Participants first completed the measures of childhood unpredictability (same as Study 6.2), childhood SES and current SES (same as Study 6.3). Then they were instructed to interact with another person online in a decision making task (i.e., a prisoner's dilemma game), during which we also manipulated resource scarcity (vs. control).

Manipulation of resource scarcity. We varied the relative initial endowment in a prisoner's dilemma game to manipulate resource scarcity (see Krosch & Amodio, 2014, Study 3). Participants were ostensibly paired with another person online (i.e., Person X). They learned that each of them would first receive some points and then decide how many points to give the other person. The points given to the other person would be doubled, and the points kept for oneself would retain the same value. Participants were told that they could initially receive up to 100 (*resource scarcity condition*) or 10 (*control condition*) points, and then were assigned 10 points in both conditions. Thus, they believed to have a relatively small amount or the maximum amount out of possible funds (10 out of 100 or 10 out of 10). We used two items (i.e., "I feel that I have received enough initial amount of points given the maximum I can get" and "I feel that I have limited amount of points to give to Person X") on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*) for the manipulation check. The number of points participants gave to the other person was the measure of cooperation.

Prior to participants' decision, they completed the SVO measure (same as Study 6.1) by choosing their preferred monetary allocation between themselves and Person X they were paired with in this task. After their decision, they learned about their partner's decision (i.e., 5 points, pre-programmed) and their earnings. Finally, they reported their age and sex, and were debriefed.

Results and Discussion

Manipulation check. Overall, participants in the resource scarcity condition (*M* = 5.76, *SD* = 1.40) perceived to have less than those in the control condition (*M* = 2.58, *SD* = 1.35), $F(1, 300) = 403.48$, $p < .001$, $\eta_p^2 = .57$. Thus, the manipulation of resource scarcity was successful.

Cooperation. We first tested whether childhood SES interacts with resource scarcity in predicting cooperation using a hierarchical regression analysis, entering resource scarcity (step 1), childhood SES (step 2), and their interaction (step 3) as predictors. Childhood SES was centered prior to analyses. Resource scarcity did not significantly predict

cooperation, β = .01, $t(300) = 0.23$, $p = .82$. Childhood SES negatively predicted cooperation, β = -.18, $t(299) = -3.24$, $p = .001$. That is, opposite to our prediction, lower childhood SES was associated with more cooperation. We found no significant Resource Scarcity × Childhood SES interaction predicting cooperation, β = -.01, $t(298) = -0.17$, $p = .87$. These results were the same after controlling for childhood unpredictability and current SES.

An alternative regression that replaced childhood SES with childhood unpredictability also revealed no significant effect of resource scarcity, β = .01, $t(300) = 0.23$, $p = .82$, childhood unpredictability, β = -.03, $t(299) = -0.54$, $p = .59$, or Resource Scarcity × Childhood Unpredictability interaction, β = .04, $t(298) = 0.42$, $p = .67$. These effects remained the same (ps > .19) after controlling for childhood SES and current SES. Thus, we found no support for Hypothesis 1 that people following slower LH strategy are more cooperative.

Social value orientation (SVO). Hierarchical regression analysis on SVO revealed no significant effect of resource scarcity, β = .02, $t(300) = 0.41$, $p = .68$, childhood SES, β = .006, $t(299) = 0.11$, $p = .91$, or Resource Scarcity × Childhood SES interaction, β = -.08, $t(298) = -0.88$, $p = .38$. These effects remained the same (ps > .32) after controlling for childhood unpredictability and current SES. Alternative regression analysis that replaced childhood SES with childhood unpredictability in the regression also revealed no significant effect of resource scarcity, β = .02, $t(300) = 0.41$, $p = .68$, childhood unpredictability, β = -.09, $t(299) = -1.58$, $p = .11$, or Resource Scarcity × Childhood Unpredictability interaction on SVO, β = -.004, $t(298) = -0.05$, $p = .96$. These effects remained the same (ps > .11) after controlling for childhood SES and current SES. Thus, we found no support for Hypothesis 4a (i.e., slower LH strategy relates to more prosocial orientation) or Hypothesis 4b (i.e., SVO mediates the relation between LH strategy and cooperation).

Study 6.5

Studies 6.1 to 6.4 found no support for the direct relation between LH strategy and cooperation. One potential explanation may be that the behavioral patterns related to LH strategy depend on specific social interaction contexts. Indeed, organisms may strategically adjust their resource allocation decisions in response to local contextual cues (Kuzawa & Bragg, 2012; McNamara & Houston, 1996). For example, contradictory findings that climatic uncertainty (vs. stability) either undermines or promotes cooperative breeding in birds (e.g., Gonzalez, Sheldon, & Tobias, 2013; Jetz & Rubenstein, 2011; Rubenstein & Lovette, 2007) suggest that life history variation in cooperation may be explained by potential moderators.

One potential moderator is one's degree of interdependence with an interaction partner (Rusbult, & Van Lange, 2003). While it is beneficial to withhold resources and act selfishly in resource-scarce environment when one can fully determine one's outcome, cooperation can be more beneficial when one is interdependent with others. Thus, outcome interdependence may be a key factor that determines how LH strategy relates to coopera-

tion. For people who tend to follow a faster LH strategy, selfish behavior might be favorable in the short term when one is outcome-independent, whereas cooperation is more appealing in outcome-interdependent situations. Thus, Study 6.5 tested the prediction that people following a faster LH strategy are more cooperative in an outcome-interdependent situation than in an outcome-independent situation, whereas people following a slower LH strategy do not vary their cooperation across the two situations (*Hypothesis 6*).

Method

Participants and design. Participants were 608 US adults (310 women, M_{age} = 34.57 years, *SD* = 11.42) recruited from MTurk. They completed the study for US$1.20. Thirteen participants won an extra 2-dollar bonus based on their decisions. They were randomly assigned to one of the four conditions in a 2 (resource scarcity: resource scarcity, control) × 2 (outcome interdependence: independent, interdependent) between-participants design. Two participants were excluded from the analyses, because one of them took the survey for the second time, and the other stated to have answered the survey questions in a reversed order.

Procedure and materials. The manipulation of resource scarcity and the measures of childhood unpredictability, childhood SES, and current SES were the same as Study 6.4, with the following exceptions:

We manipulated outcome interdependence with a modified dictator game (*outcome-independent*) and a modified trust game (*outcome-interdependent*). In the dictator game, participants (i.e., allocator) were initially endowed with 10 (out of 100 or 10) points and gave any point to a recipient, who would receive the doubled amount. In the trust game, participants (i.e., trustor) were initially endowed with 10 (out of 100 or 10) points and sent any point to a trustee, who would receive the doubled amount. Afterward, the trustee could send some of the doubled amount back to the trustor, and the amount sent back was also doubled. The number of points participants gave to their partner in each game was the measure of cooperation.

For a manipulation check of outcome interdependence, participants completed the 30-item Situational Interdependence Scale (Gerpott, Balliet, & de Vries, 2015), which includes five subscales (interdependence, temporal dimension, conflict, information certainty, and power; αs = .69, .80, .82. .77, and .95), each with six items on a 5-point Likert scale (for the first four subscales, 1 = *completely agree*, 5 = *completely disagree*; for the power subscale, 1 = *definitely the other*, 5 = *definitely myself*). Sample items for the interdependence subscale include "We need each other to get our best outcome in this situation". We reverse-scored items so that higher average score on this subscale indicated higher perceived interdependence with one's partner.

Results and Discussion

Manipulation checks. We conducted 2 (Resource Scarcity) × 2 (Outcome Interdependence) analyses of variance (ANOVA) on perceived scarcity and perceived interdependence, separately. Participants in the resource scarcity condition (M = 6.00, SD = 1.20) perceived to have less than those in the control condition (M = 2.42, SD = 1.31), $F(1, 602) = 1239.69$, $p < .001$, $\eta_p^2 = .67$. Participants in the outcome-interdependent condition (M = 4.10, SD = 0.77) perceived higher interdependence with their partner than those in the outcome-independent condition (M = 3.69, SD = 0.67), $F(1, 602) = 48.26$, $p < .001$, $\eta_p^2 = .07$. Thus, the manipulations of resource scarcity and outcome interdependence were successful.

Cooperation. We first centered childhood SES, and conducted a hierarchical regression analysis on cooperation, including resource scarcity, outcome interdependence, and childhood SES (step 1), three two-way interactions (step 2), and one three-way interaction (step 3) as predictors. Only outcome interdependence significantly predicted cooperation, $\beta = .36$, $t(602) = 9.55$, $p < .001$, with more cooperation in the outcome-interdependent situation (i.e., modified trust game; M = 6.16, SD = 3.36) than in the outcome-independent situation (i.e., modified dictator game; M = 3.64, SD = 3.10). Neither resource scarcity, $\beta = .05$, $t(602) = 1.19$, $p = .24$, nor childhood SES, $\beta = .006$, $t(602) = 0.15$, $p = .88$, significantly predicted cooperation. We found no significant Resource Scarcity × Childhood SES interaction, $\beta = .02$, $t(599) = 0.34$, $p = .74$, or Resource Scarcity × Outcome Interdependence × Childhood SES interaction, $\beta = -.03$, $t(598) = -0.33$, $p = .74$. An alternative hierarchical regression analysis that replaced childhood SES with childhood unpredictability also revealed that only outcome interdependence significantly predicted cooperation, $\beta = .36$, $t(602) = 9.57$, $p < .001$. Neither resource scarcity, $\beta = .05$, $t(602) = 1.23$, $p = .22$, nor childhood unpredictability, $\beta = -.02$, $t(602) = -0.58$, $p = .56$, significantly predicted cooperation. There were no significant Resource Scarcity × Childhood Unpredictability interaction, $\beta = -.06$, $t(599) = -1.06$, $p = .29$, or Resource Scarcity × Outcome Interdependence × Childhood Unpredictability interaction, $\beta = .006$, $t(598) = 0.08$, $p = .94$. Thus, we found no support for Hypothesis 1 that slower LH strategy relates to more cooperation, or Hypothesis 6 that outcome interdependence moderates this relation.

General Discussion

Life history theory provides an overarching theoretical framework to understand how organisms allocate limited resources to activities that enhance survival or reproduction (Del Giudice et al., 2015; Hill, 1993). Faster versus slower LH strategies manifest themselves in a variety of domains (e.g., mating, parenting, and social behaviors), and they function to tailor fitness trade-offs to varied environmental conditions (West & Gardner, 2013). Life history theory has been used to predict that a slower, compared to faster, LH strategy would relate to more investment in cooperative relationships in social interactions (e.g.,

Del Giudice, 2014; Nettle, 2010; Nettle et al., 2011), yet no empirical research has directly tested this prediction. Using large samples from Japan and the United States, the present research sought to test (a) whether slower LH strategy relates to more cooperation, (b) the potential psychological mechanisms that underlie this effect (i.e., temporal discounting, concern for reputation, SVO, and trust in others), and (c) whether situational outcome interdependence moderates the relation between LH strategy and cooperation. In Studies 6.1 and 6.2, we used a correlational approach that measured LH strategies with Mini-K and High-K Strategy Scales, and correlated them with cooperation in various economic games. In Studies 6.3 to 6.5, we measured participants' early-life environments, manipulated current resource scarcity, and operationalized life history strategy as the magnifying effects of early-life experiences contingent on current resource scarcity. Thus, a significant interaction between these two would support a link between LH strategy and cooperation (see also Griskevicius et al., 2011, 2013). Table 6.4 provides the list of hypotheses and empirical support in the present research.

Overall, we found no support for the hypothesis that a slower, compared to faster, LH strategy promotes cooperation. It is not easy to provide evidence or compelling interpretations for surprisingly weak (or null) relationships. We suggest three broad interpretations for the present findings. One interpretation is rooted in the economic games we have used, which involved only one-shot interactions with unknown others. Also, there were no cues that a (un)cooperative reputation could result in future indirect benefits or costs. It is possible that these "experimentally clean" situations do not call for motives rooted in life history. For example, it is possible that life history variations are more strongly activated in mundane situations with stronger reputational concerns, and trust that is rooted in extended social interactions. Arguing from this perspective, it was interesting to see that findings in Studies 6.1 and (or) 6.2 provided some support for Hypothesis 3a, 4a, and 5a that people following a slower, compared to faster, LH strategy are in general more concerned about their reputation, more prosocially orientated, and more likely to trust others.

A second interpretation focuses more strongly on differences among genetically related others, friends and community members, and strangers. Previous research suggests that individuals following a high-K (i.e., slower) LH strategy tend to invest more in genetically related individuals (Figueredo et al., 2005). Clearly, it is plausible that some people extend their cooperation from kin to others in their immediate social environment, in which they share histories and future interactions. Yet it might be more challenging to generalize, even partially, tendencies that are rooted in genetic fitness to complete strangers.

A third interpretation is that cooperation in economic games is often costly and involves direct monetary consequences. This is an important feature of how social and evolutionary scientists studied trust and cooperation. Yet, we suggest that social life is also about low-cost cooperation, such as sharing information with others, showing respect,

Table 6.4
Hypotheses Tested across Studies and Support (or no Support) for the Hypotheses

#	Hypotheses	Support
1	People with slower, compared to faster, LH strategy are more cooperative.	No
2a	People with slower, compared to faster, LH strategy value future rewards more than immediate benefits.	No
2b	Temporal discounting mediates the relation between LH strategy and cooperation.	No
3a	People with slower, compared to faster, LH strategy are more concerned about their reputation.	Yes
3b	Concern for reputation mediates the relation between LH strategy and cooperation.	Partly
4a	People with faster, compared to slower, LH strategy display more proself orientation.	Partly
4b	Social value orientation mediates the relation between LH strategy and cooperation.	Yes
5a	People with faster, compared to slower, LH strategy are less likely to trust others.	Yes
5b	Trust in others mediates the relation between LH strategy and cooperation.	Partly
6	People with faster, compared to slower, LH strategy are more cooperative in an outcome-interdependent situation than an outcome-independent situation.	No

and conveying appreciation such as gratitude and compliments (for related reasoning, see Van Lange & Van Doesum, 2015). It is possible that life history variations are especially expressed in these daily acts of low-cost cooperation, such that people with slower LH strategies (or benign early-life environments) may have adapted to exchange "favors" that are often nonmonetary, including activities that provide mutual help and support in daily life.

Nevertheless, the consistent finding of no direct relation between LH strategy and cooperation in economic games across our studies does contribute to extant literatures on life history variation in social decision making (e.g., cooperation in mixed-motive situations). Future research could focus especially on differences between kin, friends, community members, and strangers, and contexts where reputational concerns and interaction-based trust are more salient.

Although both theory and empirical evidence suggest that the preference for larger delayed rewards rather than smaller immediate rewards is an important feature of slower LH strategy (see Griskevicius et al., 2011, 2013), we did not find any evidence for Hypothesis 2a that a slower LH strategy leads to more valuation of future reward (vs. immediate benefits). However, this result does parallel some recent inconsistent findings that future discounting is not associated with overall death exposure that may induce faster LH strategy (Pepper & Nettle, 2013), or that thoughts of death increases subjective value of future (Kelley & Schmeichel, 2015). Indeed, a recent study that compared four "time preference" measures (i.e., impulsivity, sensation seeking, future orientation, and delay discounting) suggests that only sensation seeking consistently predicts life history variables (Copping, Campbell, & Muncer, 2014). Thus, future research needs to test how temporal discounting, along with other relevant "time preference" measures, relates to LH strategies that are adaptive responses to systematically different environments (e.g., harsh versus unpredictable environments).

Strengths, Limitations, and Future Directions

The present research is among the first attempts to integrate life history theory with research on social decision making, in particular cooperation. Five studies contained convergent evidence from relatively large and diverse samples from both an Asian and a Western society. Additionally, we applied both correlational and experimental methods to test our hypotheses, and a total of fifteen different economic games to measure cooperation. Indeed, the significant correlations between cooperation in different games suggest that they tapped the same construct of cooperation (Peysakhovich, Nowak, & Rand, 2014; Yamagishi et al., 2013, 2014).

Before closing, we should also acknowledge limitations and potential avenues for future research. First, some of our studies manipulated resource scarcity through either a slideshow or different relative initial endowments in the interaction context. Indeed,

resource scarcity is an indicator of current environmental harshness, whose effect may differ from that of environmental unpredictability, such as unpredictable climate changes (Ellis et al., 2009). Thus, future research needs to distinguish cues of harshness and unpredictability in current (or future) environment and investigate how they influence the expression of faster or slower life history traits. Second, our cooperation measures mainly focused on one-shot interaction with unknown others, and could not distinguish cooperative behavior in different interpersonal contexts. An important avenue for future research is to clarify how variations in cooperation fit with a life history framework, and to investigate potential moderating factors. For example, one approach is to investigate whether the optimal LH strategies relate to how people compute welfare tradeoff ratios based on a series of internal regulatory variables that encode features of the other person (e.g., kinship, value as a reciprocal partner) and the situation (e.g., cues of being watched by others) (see Delton & Robertson, 2016).

Concluding Remarks

Life history strategy reflects an individual's adaptive responses to early-life and current living environments, and have important psychological and behavioral consequences. The present research focused on how tendencies to follow faster or slower LH strategies relate to cooperation. Overall, LH strategy does not relate to one's effort to invest in cooperative relationships in situations with conflict of interests between self and unknown others. This initial finding implies that life history theory does not account for individual variation in cooperative strategies in economic games with unknown others. However, the current research does provide some evidence that people following a slower, compared to a faster, LH strategy displayed an enhanced level of concern for reputation, prosocial orientation, and trust in others, and these psychological factors partly explained the relation between LH strategy and cooperation.

Acknowledgment

This research was supported in part by a fellowship from China Scholarship Council (201206040030) awarded to Junhui Wu.

Supplementary Materials

Method (Study 6.1)

Experimental Settings for All Economic Games

Four to ten people participated in each session. They were seated in separate cubicles numbered from 1 to 10, and did not know how many others were participating. Participants read the instructions displayed on their own computer screen in separate cubicles. Instructions were presented with animated cartoons to facilitate intuitive understanding of the games.

Prisoner's Dilemma Game (PDG)

Repeated one-shot prisoner's dilemma game (PDG1). Participants were endowed with either JPY 300, 800, or 1,500, which varied across trials. They decided whether to give their endowment to their partner or keep it for themselves. If either of them chose to give, the partner received twice the amount of the endowment. For example, when the endowment was JPY 1,500, the partner received JPY 3,000 if participants chose to give. Similarly, participants received JPY 3,000 if their partner gave the endowment to them. When participants did not give, they earned the endowment.

Each participant played (a) a simultaneous game, and a sequential game as (b) a first player and (c) the second player, each game with three different stake sizes (i.e., JPY 300, 800, or 1,500). In the simultaneous game, two players make decisions without knowing the other's choice. In the sequential game, the first player makes a choice, and then the second player makes a choice after knowing the first player's choice. When participants played as a second player, they decided whether to give or keep their endowment twice, assuming once that the first player had decided to give, and once that the first player had decided not to give (*strategy method*). The outcome of the game was determined by both partners' choices. Each participant played the game once for each combination of role and endowment size (nine games in total). They learned that they would be paid for three of the nine games. When participants finished these games, one game was randomly selected from each stake size for their actual payment. Each participant was randomly matched with another participant for each of the three games and paid for each game based on their choices. Cooperation in this game was the proportion of trials in which participants gave the endowment to their partner, excluding their responses in the sequential game trials as a second player when the first player defected, because only very few of them cooperated in these trials.

One-shot prisoner's dilemma game (PDG2). In this game, both participants were endowed with JPY 1,000 and decided simultaneously how much of this amount to give to their partner in increments of JPY 100. Any amount given to the partner was doubled. For

example, when participants gave JPY 300 to their partner, the partner received JPY 600. Similarly, participants received JPY 1,200 if their partner gave them JPY 600. Any amount not given to their partner was kept for themselves. Cooperation in this game was the proportion of endowment participants gave to their partner.

Dictator Game (DG)

All participants first played a one-shot dictator game as an allocator and decided how to divide an endowment, knowing that half of them would be assigned as the recipients after their decision. Each participant was endowed with JPY 1,000 and decided to give any of these to the recipient. Participants were actually paid according to this method. After this initial one-shot dictator game, they played another one-shot repeated dictator game with six different recipients. The size of the endowment varied from JPY 300 to JPY 1,300 (i.e., 300, 400, 600, 700, 1,200, and 1,300). Participants learned that they would play the game several times but did not know how many times they would play the game. They made allocation decisions in increments of 10% as the allocator in each game, knowing that two games would be selected for actual payment. In one of the two games, they were assigned as the allocator, and received the money they kept for themselves. In the other game, they were assigned as the recipient, and received the money allocated to them by the matched participant. They were actually paid according to this scheme. Cooperation measures in the two games were (a) the proportion of endowment participants gave to the recipient in the first one-shot dictator game, and (b) the average proportion of endowment they gave to the recipient in the second one-shot repeated dictator game.

Faith Game (FG)

In the faith game, each participant acted as a trustor, and was matched with another participant who previously played a dictator game (DG) as an allocator. They were reminded that the allocator in the DG had decided how much of JPY 1,000 to give to someone in increments of JPY 100. Next, participants were given JPY 1,000 and decided how much to invest in a matched participant. The invested money would be tripled and returned to the participant according to the proportion that the matched participant had decided to allocate to the recipient in the earlier DG. For example, if a participant invested JPY 400 and the matched participant allocated 40% of the endowment in an earlier DG, the participant would receive JPY 480 plus JPY 600 that was kept for him/herself. Cooperation in this game was the proportion of endowment participants invested in the matched participant.

Social Dilemma Game (SDG)

Participants played a social dilemma game in Waves 4 and 8. They learned that they would play the game in a group without knowing the actual group size. While the instruction was written for a 10-person group, they were told that the actual group size could vary. Partici-

pants played the game only once, and were paid according to their earnings in the game. Each participant was endowed with JPY 1,000 and contributed any of this amount to a public good in increments of JPY 100. Total contribution to the public good was doubled and equally divided among all members regardless of their contribution. Cooperation in each game was the proportion of endowment participants contributed to the public good.

Trust Game (TG)

The trust game involved two randomly matched participants: a trustor and a trustee. The trustor received an initial endowment of JPY 1,000 and decided how much of it to send to the trustee in increments of JPY 100. The money sent to the trustee was then tripled. The trustee received the tripled amount of money and decided how much of it to send back to the trustor. The money they sent back remained the same value. Participants learned that they would play the game twice, each time with a different partner and in a different role. After reading the instructions, they were all assigned to be the trustor and decided how much of JPY 1,000 to send to the trustee. The first game ended after they made their decisions as trustors. Then they were told that they would play the game again with a different partner as a trustee. In the second game, participants were asked to indicate the amount of money they would send back to the trustor in increments of 10% of the tripled money for 10 possible decisions of the trustor (i.e., when the trustor sent JPY 100, 200, 300, 400, 500, 600, 700, 800, 900, or 1,000) (*strategy method*). Finally, participants were randomly paired with each other, with one of them randomly chosen as a trustor and the other as a trustee. Each participant's earnings as a trustor depended on the money they had sent in the first game and the money that the randomly matched trustee chose accordingly in the second game. Cooperation measures in this game were (a) the proportion of endowment participants sent to their partner as a trustor in the first game (i.e., trust), and (b) the mean proportion of the tripled money they sent back as a trustee for all the possible decisions of the trustor in the second game (i.e., trustworthiness).

Ultimatum Game (UG)

The ultimatum game was played between two randomly matched participants: a proposer and a responder. The proposer initially received JPY 1,500 from the experimenter and decided how much of this amount to give to the responder in increments of JPY 100. After his/her decision, the responder decided whether to accept or reject this offer. If the responder chose to accept, the endowment was divided according to the proposed offer; if the responder chose to reject, both parties received nothing. Participants decided (a) how much of JPY 1,500 to offer to the responder when they were the proposer, and (b) whether to accept or reject 16 possible offers (i.e., JPY 0 to JPY 1,500, in increments of JPY 100) when they were the responder (*strategy method*). Finally, participants were randomly matched with another participant, once as a proposer, and once as a responder. They were

actually paid according to their own and the matched participant's decisions. The proportion of endowment participants offered to the responder as a proposer was the measure of cooperation.

Third-Party Punishment Game (TPPG)

The third-party punishment game was played between three randomly matched participants: an allocator, a recipient, and an observer. The allocator initially received JPY 1,500 and decided how much of this amount to give to the recipient in increments of JPY 100. The recipient had no choice but to passively accept the amount they were given. Afterward, the observer decided how much of JPY 375 (in increments of JPY 25) to spend to reduce the money that the allocator kept. Any amount used to punish the allocator reduced four times of this amount from the allocator's earnings. Participants decided (a) how much of JPY 1,500 to give to the recipient as an allocator, and (b) how much to spend to reduce the allocator's earnings as an observer assuming 16 possible allocation decisions (i.e., JPY 0 to JPY 1,500, in increments of JPY 100) (*strategy method*). Finally, participants were randomly paired with each other, with two of them randomly chosen as the allocator and the recipient, and the other being the observer. Their final earnings in this game depended on each of their roles and decisions. This game was played twice during which the observer who could punish either had no punishment fund, or had a punishment fund of JPY 500. Thus, the range of participants' earnings was either [-375, 1,500] or [125, 1,500] depending on each other's roles and decisions. Cooperation was the average proportion of endowment participants gave to the recipient as an allocator across the two games.

Impunity Game (IG)

The impunity game involved two randomly matched participants: a proposer and a responder. The proposer was initially endowed with JPY 1,500, and decided how much of this amount to offer to the responder in increments of JPY 100. Afterward, the responder decided whether to accept or reject this offer. If the responder chose to accept, the endowment was divided according to the proposed offer; if the responder chose to reject, the responder left the game with nothing, whereas the proposer still earned the amount kept for self. Participants played this game twice. They were first assigned to be the proposer and decided how much of JPY 1,500 to offer to the responder. Then they were asked to accept or reject 16 possible proposed offers (i.e., JPY 0 to JPY 1,500, with increments of JPY 100) as a responder (*strategy method*). Finally, participants were randomly matched with another participant, once as a proposer and once as a responder. Their earnings (range: JPY 0 to JPY 3,000) were calculated based on their decisions as different roles. Cooperation was the proportion of endowment participants offered to the responder as a proposer in this game.

Stag Hunt Game (SHG)

The stag hunt game involved two randomly matched participants who decided simultaneously whether to invest in their partner or not. If they both chose to invest in their partner, both earned JPY 1000; If one of them chose to invest, whereas the other did not invest, then the one who invested earned nothing, whereas the other earned JPY 500; If both parties chose not to invest, then both earned JPY 500. Cooperation in this game was participants' decision to invest (or not invest) in their partner.