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Citation

TAN, Kenneth, LI, Norman P., MELTZER, Andrea. M., CHIN, Joel L. J., TAN, Kai Lin Lynn, Lim, Amy J., NEUBERG, Steven. L, & van VUGT, Mark.(2022). Effects of economic uncertainty and socioeconomic status on reproductive timing: A life history approach. *Current Research in Ecological and Social Psychology, 3*, 1-10.
Available at: https://ink.library.smu.edu.sg/soss_research/3569

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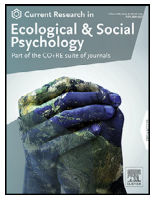
Current Research in Ecological and Social Psychology 3 (2022) 100040

Contents lists available at ScienceDirect

Current Research in Ecological and Social Psychology

journal homepage: www.elsevier.com/locate/cresp



Effects of economic uncertainty and socioeconomic status on reproductive timing: A life history approach

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ARTICLE INFO

Keywords:
Economic uncertainty
Reproductive timing
Life history theory
Socioeconomic status

ABSTRACT

Why do some people have children earlier compared to others who delay reproduction? Drawing from an evolutionary, life history theory perspective, we posited that reproductive timing could be influenced by economic uncertainty and childhood socioeconomic status (SES). For individuals lower in childhood SES, economic uncertainty influenced the desire to reproduce earlier compared to individuals higher in childhood SES. Furthermore, the decision regarding reproductive timing was influenced by tradeoffs between earlier reproduction or furthering one's education or career. Overall, economic uncertainty appears to shift individuals into different life history strategies as a function of childhood SES, suggesting how ecological factors and early life environment can influence fertility-related decisions at the individual level and may contribute to the highly variable fertility patterns observed across countries.

Since 1965, fertility rates around the world have, on average, declined by over half; yet there remains tremendous variability across countries (World Bank, 2017). Whereas fertility rates remain high in many countries, they have become quite low—indeed, well below replacement (i.e., fewer than 2.1 births per woman)—in many other countries. Notably, high fertility rates are often associated with lagging economic development, disease, hunger, and susceptibility to natural and economic threats whereas low fertility rates increase countries' susceptibility to a slew of socioeconomic problems linked, for example, to aging populations and decreased economic competitiveness (McDonald, 2007). Accordingly, it seems important to better understand the psychology underlying people's childbearing expectations (Brauner-Otto and Geist, 2018).

Economic circumstances (e.g., employment prospects, income, and financial security) are often cited as leading factors shaping fertility behavior (Hashmi and Mok, 2013). Recent demographic research shows that economic circumstances and fertility outcomes move in tandem with one another (Hanappi et al., 2017). Due at least in part to the substantial costs of raising children (Adda et al., 2017), financial strain or resource constraints likely contribute to lowered fertility (Hofmann and Hohmeyer, 2013), which allows parents to invest appropriately in the (fewer) children they do choose to have (Aarssen, 2005). Despite the intuitive appeal of this logic, research examining the relationship between economic circumstances and fertility outcomes has largely been correlational; causal evidence is lacking (Brauner-Otto and Geist, 2018), and little is known about the underlying psychological mechanisms. Drawing from life history theory, the current research seeks to bridge these gaps by investigating the causal effects of economic uncertainty on individuals' desires regarding reproductive timing, which are likely a major determinant of their actual reproduction (i.e., their reproductive success) and collectively, the fertility rates observed at the countrywide level.

Life history theory

Life history theory posits that living organisms have finite resources such as time and energy, and it seeks to understand how organisms differentially allocate such limited resources to activities that enhance their reproductive fitness (Del Giudice et al., 2015; Ellis et al., 2009). These allocations are grouped into two broad classes—*somatic effort* (allocating resources in ways that enhance embodied and social capital, and ultimately benefit delayed courtship, gestation/birth, and offspring care) and *reproductive effort* (allocating resources to prioritize earlier courtship, gestation/birth, and offspring care). Fundamental to life history theory is the notion of tradeoffs: time and energy are limited and thus an investment in one direction cannot be made in the other.

An individual's *life history strategy* is the pattern of investment tradeoffs made across the lifespan. A "slow" life history strategy favors somatic over reproductive effort—that is, a delay of sexual maturation and acceptance of a lower immediate reproduction rate in order to invest in

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https://doi.org/10.1016/j.cresp.2022.100040
Received 17 May 2021; Received in revised form 19 January 2022; Accepted 13 February 2022
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competencies that potentially yield high future returns (e.g., in humans, long apprenticeships or formal education). Slow strategists can be seen as long-term planners who delay immediate gratification for increased future payoffs. In contrast, a "fast" life history strategy favors reproductive over somatic effort—trading off investments in competencies for earlier sexual maturation, rapid reproduction, and a greater number of offspring (but with less investment in each). Fast strategists can be seen as present-focused, seeking immediate benefits with a lesser focus on future consequences and opportunities (Griskevicius et al., 2011).

What conditions lead organisms to adopt slow versus fast life history strategies? Two ecological dimensions are particularly relevant to the present investigation: harshness and unpredictability (Ellis et al., 2009). Harshness refers to the rate at which external factors can lead to death and disability at any given age in a population whereas unpredictability refers to the rates at which harshness varies across time and space. Generally, harsh and unpredictable environments favor a faster life history strategy, as this strategy increases the likelihood of achieving reproductive success by reproducing prior to death (Lu et al., 2017; Promislow and Harvey, 1990). In contrast, when the environment is less harsh and more predictable, the slower strategy of investing in long-term outcomes is prioritized so that the likelihood of survival is increased for future reproduction. Thus, at the core of this life history framework is that, due to the finite and limited resources available to organisms, there is a fundamental tradeoff between current reproduction versus future reproduction, just like a bank account (Kenrick and Luce, 2000). That is, utilizing resources for current reproduction enhances the possibility of reproductive success and the continued replication of the organisms' genes in the face of harshness and unpredictability, but conserving resources for future reproduction grants organisms the ability to create higher quality offspring in the future. Importantly, the adoption of fast or slow strategies is neither good nor bad but is adaptively contingent on the environment (Ellis et al., 2009; Kavanagh and Kahl, 2018).

One last concept from recent elaborations of life history theory is useful for the current investigation: Life history strategies are sensitive to early life environments and may even be loosely "anchored" by them. The loose anchoring of life history strategies from cues encountered in early life makes sense because, in ancestral times, environmental harshness and unpredictability likely exhibited little change from ancestral humans' childhood to adulthood (Ellis, 2004). Indeed, ecological conditions in human fetal and childhood periods can be critical for determining life history strategy (Belsky, 2007), such that *current* life stressors induce responses in adults that reflect the life history strategies set forth in childhood (e.g., Griskevicius, Delton et al., 2011; Griskevicius, Tybur et al., 2011). That is, whereas adults from different childhood environments might behave similarly in benign and nonthreatening conditions, they may behave very differently when threatened with adversities.

Economic uncertainty, life history strategy, and fertility

According to life history theorists, a major form of environmental harshness is resource scarcity (Ellis et al., 2009). In ancestral times, being devoid of resources or experiencing fluctuations in resource availability likely meant early death. Hence, individuals developed adaptive responses to cues of resource scarcity and its uncertainty (e.g., Chakravarthy and Booth, 2004). Indeed, Griskevicius et al., (2011), found that mortality cues had effects on reproductive timing based on an individual's socioeconomic status. In modern societies however, mortality cues might be less relevant to the middle- and upper-class individuals who comprise the bulk of the puzzling low fertility phenomenon. Importantly, even though resource scarcity might not be life threatening, people in modern societies are still susceptible to resource/economic scarcity cues via evolved mechanisms due to its link with mortality in the ancestral past (Adler et al., 1994; Chen et al., 2002). Moreover, in environments with fierce competition such as modern cities, research has shown that economic endeavors like earning money and achieving status is excessively prioritized over reproduction (Yong et al., 2019), highlighting the saliency and relevance of examining economic uncertainty and its effects on fertility.

In line with these links, researchers commonly operationalize harshness in economic terms and have connected it to various life history strategies. For instance, numerous studies have examined how harshness in terms of low income and resource scarcity are linked to reproductive outcomes including earlier age at first sexual intercourse and higher rates of premarital pregnancy (e.g., Woodward et al., 2001; Wu and Martinson, 1993). Other recent work has found that growing up in resource-scarce versus resource-abundant environments may sensitize people to adopt different life history strategies. Using socioeconomic status (SES) as a proxy for childhood resource availability and thus, harshness, Griskevicius et al. (2011) found that when people were facing mortality cues (e.g., increase in shootings and violent crime), their resultant preferred reproductive timing differed according to their childhood SES, such that individuals raised in lower-SES environments desired to have children sooner (faster strategy) whereas those from higher-SES backgrounds opted to delay reproduction (slower strategy). Notably, however, neither line of previous work examined *current economic uncertainty* as a possible determinant of reproductive strategy.

That resource scarcity constitutes a major component of harshness (Hill et al., 2012) suggests that uncertainty of resources, or economic uncertainty (beyond scarcity alone), is likely a major and increasingly prevalent form of unpredictability in modern society—and one that may have important consequences for reproductive strategies. Economic uncertainty connotes not only a potential lack of resources but also the *risk* of future failures both in somatic and reproductive effort. Indeed, the effect of unpredictability on reproductive outcomes has been shown in various studies to exceed the effect of harshness itself (for a review, see Ellis et al., 2009). As a modern-day cue to ecological unpredictability and mortality threat (Mittal and Griskevicius, 2014), economic uncertainty could thus lead to the selection of different life history strategies. Economic uncertainty has been shown to affect tradeoffs related to life history, such as spending versus saving (Griskevicius et al., 2013) and making risky versus safe economic decisions (Griskevicius et al., 2011; Lu and Chang, 2019), but has not been examined with respect to reproductive timing—a variable both critical to individual fitness (Belsky et al., 2012; Ellis, 2004) and having large implications for societal fertility and well-being. Thus, as described below, we extend Griskevicius' et al. (2011) findings and examine the implications of economic uncertainty for reproductive timing and related trade-offs.

The current research

Research on life history theory has shown that life history strategies operate on the fast-slow continuum and typically differ *between* species (see Del Giudice, 2020; Sear, 2020). For example, humans have comparably slower life history strategies, investing more in somatic effort and reproducing at a later age compared to other species (e.g., chimpanzees) that show faster life history strategies (Kaplan et al., 2000). Although some have questioned life history theory's applicability in understanding *within*-species variation (see Zietsch and Sidari, 2020), much research has documented extensive reproductive variability within species (e.g., Tinbergen and Both, 1999), including humans. For example, adaptive variability in life history strategies exist within species like the great tit, such that some members of these species delay reproduction (i.e., have smaller clutch sizes or number of eggs laid per year) compared to other members of the same species in response to the environmental context (e.g., Tinbergen and Both, 1999). Indeed, these life history strategies are adapted as well as in humans and are tied to cues such as environmental uncertainty (e.g., mortality cues; resource scarcity etc.). Given that there exist various environmental contexts that have different implications for reproduction, evolution would have selected for flexibility in terms of strategies used to allocate resources toward reproductive or somatic effort (Stearns, 1989). Consistent with this idea, prior

research has shown that women have earlier ages of first birth in places that have shorter life expectancies (Wilson and Daly, 1997). Hence, humans do not possess fixed strategies unresponsive to the environment but monitor the current and expected state of the environment and adapt life history strategies accordingly (Ellis et al., 2009; Griskevicius et al., 2013; Mittal and Griskevicius, 2014).

Here, we extend past literature by experimentally examining whether current economic uncertainty—i.e., cues to the ability to garner resources—moderates the association between people's early life environments and their desired reproductive timing—a major determinant of people's actual reproduction and hence, the fertility patterns that we observe across nations. Following the reasoning articulated above, we hypothesized that, when faced with current economic uncertainty (an increasingly common form of current ecological unpredictability), individuals raised in poorer (and thus, harsher) childhood environments would seek to have children sooner (consistent with a faster life history strategy) whereas individuals raised in wealthier childhood environments would seek to delay reproduction (consistent with a slower life history strategy).

We contend that this critical difference in life-history-strategy behaviors emerges with exposure to current economic uncertainty because the life history strategies set forth in childhood most likely activate in response to harsh conditions or morbidity-relevant stressors (Griskevicius et al., 2011). That is, because individuals raised in poorer childhood environments generally are sensitized to conditions that are more unpredictable and dangerous, they have adopted a faster strategy that, when faced with morbidity-relevant stressors, adaptively discounts the future and maximizes immediate rewards—i.e., behaviors promoting earlier reproduction. Conversely, individuals raised in wealthier environments generally are sensitized to conditions that are more predictable and manageable and, thus, have adopted a slower strategy that, when faced with such stressors, facilitates delay of gratification and, consequently, reproduction (Mittal and Griskevicius, 2014). In safe and predictable environments, however, individuals might have greater energy budgets and behave similarly in these benign and nonthreatening conditions, thereby counteracting their prevailing childhood sensitizations (Walker et al., 2006). Additionally, we aimed to provide some insight behind these effects by focusing on the tradeoff between current and future reproduction in which starting a family sooner is pitted against furthering one's education and career, and whether this tradeoff has a mediating effect on reproductive timing.

Study 1

The aim of Study 1 was to examine whether individuals raised in poorer or wealthier environments express different reproductive timing when faced with current economic uncertainty.[1]

Method

Participants

Minimum sample size was calculated for both studies by using the recommended minimum effect size (RMPE) representing a "practically" significant effect for social science data of partial r = .20 (Ferguson, 2009). A power analysis using G*Power (Faul et al., 2007) suggests a sample size of 156 participants, at α = .05 and power set at .80. This is also within the sample sizes of studies that examined mortality, childhood SES, and reproductive timing (n = 106-182) (Griskevicius et al., 2011). Participants were 267 undergraduates (64 men, 203 women; M_{age} = 21.84, SD_{age} = 1.67) from a public Singapore university who signed up and received participation credit via the Subject Pool System. Efforts were made to collect as many participants as possible based on available resources throughout the semester and thus we ended up recruiting a larger sample size than the minimum sample size needed.

Table 1
Correlations among variables and descriptive statistics, Study 1

Variable	1	2	3	Mean (SD)
1. Condition	-			
2. Childhood SES	.01	-		4.22 (2.27)
3. Desired Age to have First Child	-.01	-.06	-	7.86 (2.59)

Note: ** p <.001. Condition was coded -1 for economic certainty and 1 for economic uncertainty.

Procedure and measures

Participants were randomly assigned to one of two between-subjects conditions (current economic uncertainty, current economic certainty) in which they read a hypothetical scenario about the recent certainty of attaining career goals and social standing.

The *economic uncertainty condition* included the following:

> Next week is your annual performance evaluation and you do not know how that will go! If you wish to become successful someday, you really need to get a promotion as soon as possible. However, it is very hard to predict whether you will get promoted, demoted, or even lose your job!

The *economic certainty condition* included the following:

> Next week is your annual performance evaluation and you believe it will go well! You expect that you will be offered a permanent contract. Getting a permanent contract is definitely going to give you even greater job security.

Manipulation check. Following the manipulation, participants indicated the extent to which they perceived economic uncertainty by indicating agreement (1 = *not at all,* 9 = *definitely*) with two items: (a) Do you feel your social status is uncertain, and (b) Do you feel your social status is unstable (α = .88).

Timing of first child. We assessed the number of years in which participants desired to have their first child as a proxy for reproductive timing. Specifically, we modified two items developed by Griskevicius, Delton et al. (2011). The first item was open-ended: "Assume that you will have children. At what age would you like to have your first child?" The second item stated: "Assume that you will have children. In how many years from now do you want to have your first child?" Responses to the first item were transformed by subtracting participants' age from their response; obtained values indicated the number of years from the present that participants want to have their first child. The two items were averaged into an index of reproductive timing (α = .79).

Childhood SES. We assessed objective childhood SES by asking participants to indicate their childhood family annual income on an 8-point scale (1 = *$15,000 or less*, 2 = *$15,001 - $25,000*, 3 = *$25,001- $35,000*, 4 = *$35,001 - $50,000*, 5 = *$50,001 - $75,000*, 6 = *$75,001 - $100,000*, 7 = *$100,000 - $150,000*, 8 = *$150,000 or more*).

Finally, participants provided demographic information. Participants then received course credit and were debriefed.

Results and discussion

Manipulation check

Both childhood SES (z = .05) and desired age of reproduction (z = 1.23) had acceptable levels of skewness; correlation and descriptive statistics can be found in Table 1. We conducted an independent samples t-test on the manipulation check. As intended, participants perceived greater economic uncertainty in the economic uncertainty scenario ($M_{Uncertainty}$ = 5.39) than they did in the economic certainty scenario ($M_{Certainty}$ = 4.11), $t(265)$ = 5.07, d = 0.6, p < .001.

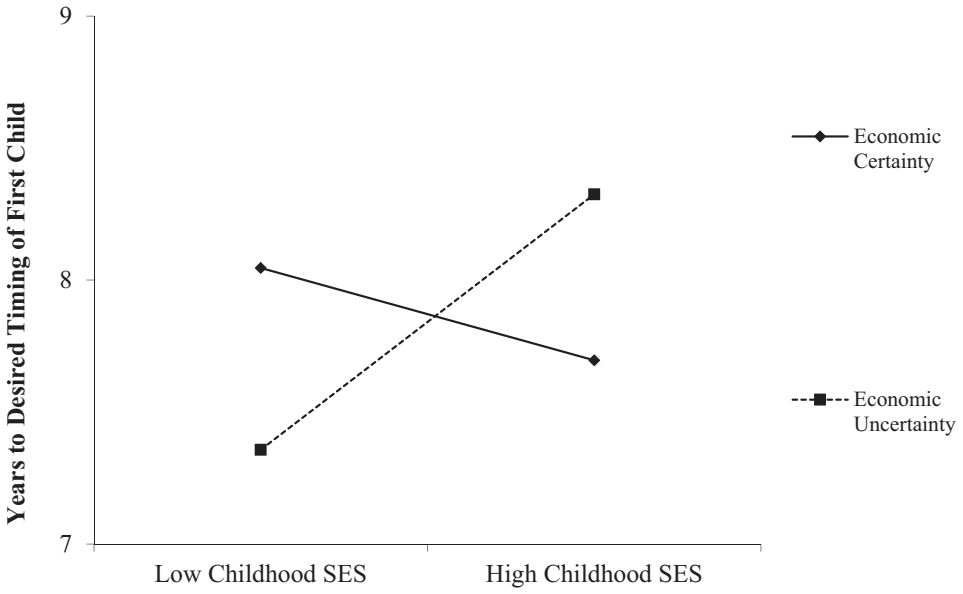

Fig. 1. Years to desired timing of having first child as a function of childhood SES and economic uncertainty cues in Study 1.

Timing of first child

First, there was neither a main effect of participant sex, nor any interactions involving participant sex, on participants' desired reproductive timing (all *ps* > .22); male and female participants exhibited similar patterns of desired reproductive timing.

Using multiple regression analyses to test for the two-way interaction between centered childhood SES and economic uncertainty (-1 = economic certainty, 1 = economic uncertainty) as predictors of desired timing to have a first child, we found neither a significant main effect of economic uncertainty, b = -0.02, $t(263)$ = -0.09, β = -0.06, p = .93; 95% Confidence Interval (95% CI) [-0.32, 0.29], nor a significant main effect of childhood SES, b = 0.07, $t(263)$ = 0.98, β = 0.07, p = .33; 95% CI [-0.06, 0.20]. Consistent with our hypothesis, however, there was a significant economic uncertainty × childhood SES interaction, b = 0.15, $t(263)$ = 2.09, β = 0.13, p = .04, R^2 = 0.02; 95% CI [0.01, 0.28].

As predicted (see Fig. 1), the association between childhood SES and reproductive timing depended on the extent to which the current environment was characterized by economic uncertainty (versus certainty). Among participants in the economic uncertainty condition, those with higher (versus lower) childhood SESs desired children significantly further in the future, b = 0.21, $t(263)$ = 2.16, p = .03; 95% CI [0.02, 0.41]; among participants in the economic certainty condition, we did not detect an association between childhood SES and desired reproductive timing, b = -0.08, $t(263)$ = -0.79, p = .43; 95% CI [-0.27, 0.12].

Test of simple slopes at high (+1 *SD*) and low (-1 *SD*) levels of childhood SES revealed, however, that the individual simple slopes indicating an effect of economic uncertainty only approached significance for both low-childhood SES individuals, b = -0.35, $t(263)$ = -1.54, p = .12; 95% CI [-0.79, 0.10] and high-childhood SES individuals, b = 0.32, $t(263)$ = 1.42, p = .16; 95% CI [-0.12, 0.76].

In summary, Study 1 revealed that people's childhood environments interacted with current economic uncertainty cues to affect their desired timing to have a first child. Consistent with hypotheses, individuals from wealthier (versus poorer) backgrounds reported relatively later desired reproductive timing when faced with economic uncertainty, but not when faced with economic certainty.

It could be argued that a weakness of Study 1 was that economic uncertainty could have been confounded with negative affect when compared with economic certainty. It could also be argued that we had manipulated not only economic uncertainty but also status uncertainty, which is linked to access to resources. Furthermore, because we contrasted economic certainty versus uncertainty, there is no default baseline condition by which comparisons can be made. Hence, we conducted a second study to rule out these confounds and to replicate our key interaction between childhood SES and economic uncertainty.

Study 2

Study 1 showed initial support for the hypothesized interaction between childhood SES and economic uncertainty cues on reproductive timing. Study 2 sought to conceptually replicate and extend those findings. First, we used an established manipulation of economic uncertainty (Griskevicius et al., 2011). Next, in lieu of the economic certainty condition from Study 1, we employed a comparison condition designed to elicit negative arousal levels similar to the economic uncertainty condition to rule out the alternative explanation that negative arousal or general stress (rather than uncertainty, *per se*) induced the observed effects in Study 1. Furthermore, in addition to directly assessing desired timing to have a first child, we used another index of reproductive timing and assessed attitudes towards (earlier) reproduction to examine intentions and evaluations regarding having children earlier. Finally, in addition to objective childhood SES, we also assessed subjective childhood SES with subjective measures of SES (i.e., one's *perception* of position compared with others), which have been shown to discriminate more nuanced variations in the social environment compared to objective measures (e.g., Tan et al., 2020).

Further, Study 2 examined the mediating effect of reproductive vs. somatic effort desire (Griskevicius et al., 2011). We hypothesized that in response to economic uncertainty, individuals raised in wealthier childhood environments would invest in somatic effort at the expense of reproductive effort, whereas individuals reared in poorer childhood environments would prioritize reproductive effort instead. We operationalized this tradeoff as navigating the contingency by prioritizing family (i.e., reproductive effort) versus career (i.e., somatic effort). Moreover, we expected this tradeoff between reproductive vs. somatic effort desire would mediate the interactive effect of childhood SES × economic uncertainty on reproductive timing.

Method

Participants

Participants were 123 undergraduate students (34 men, 89 women; M_{age} = 21.80, SD_{age} = 1.84) from a public Singapore university who signed up and received course credit via the Subject Pool System. As

in Study 1, efforts were made to collect as many participants as possible based on available resources throughout the semester. Because of the smaller number of participants compared to our a priori sample size computation, we conducted a post-hoc power analysis. Our analysis showed that our sample had .88 power to detect our smallest effect size of a partial r = -.26.

Procedure and measures

Participants were randomly assigned to two between-subject conditions (economic uncertainty, control). In both conditions, participants read a short newspaper article, but the articles differed in critical ways.

The *economic uncertainty condition* included the following:

> According to annual surveys of recent graduates from local universities, only 68.9 percent of graduates last year managed to secure full-time permanent employment six months after their final examinations. This figure was the lowest in 10 years, down from 79.9 percent in 2016, and 89.9 percent in 2007.

The *control* condition was designed to elicit similar levels of negative affect describing a person searching for his lost keys (see Griskevicius et al., 2010) and included the following:

> My first day in town, I left the keys to the truck on the counter of a coffee shop. The next day, I left the keys to the house in the front door. A few days after that, warming up in the midday sun of an outdoor café, I took off the long-sleeved shirt I'd been wearing, only to leave it hanging over the back of the chair when I headed home. When I returned to claim it, I discovered that I'd left my wallet behind as well.

Manipulation check. Participants indicated the extent to which they perceived that the economic climate was difficult and uncertain by indicating agreement with three items (1 = *not at all,* 7 = *definitely*): (a) I am afraid that I will not get a good job in the future, (b) In the future, my salary will not be sufficient to make a living, and (c) I am fearful of my future economic situation (α = .87).

Additionally, participants completed the 10-item International Positive and Negative Affect Schedule Short-Form (I-PANAS-SF; Karim et al., 2011) to assess affective states (1 = *not at all,* 5 = *extremely*) after reading the articles. Positive (negative) affect was assessed by averaging responses to the five positive (negative) affective states ($\alpha_{positive}$ = .76, $\alpha_{negative}$ = .85).

Timing of first child. Participants responded to the same two items from Study 1 regarding when they expected to have their first child (α = .99).

Reproductive timing attitude. To assess attitudes toward early reproduction, participants responded to three items: "Would you like to have children in the next few years?" (1 = *definitely no,* 7 = *definitely yes*); (2) If you were to have a child in the next few years, how would you feel?" (1 = *extremely negative,* 7 = *extremely positive*); and "How disappointed would you be if you do not have a child in the next few years?" (1 = *not at all,* 7 = *very;* α = .78).

Reproductive versus somatic effort desire. To assess prioritizing reproductive effort versus somatic effort, participants indicated their preferences for starting a family sooner versus delaying reproduction to invest in one's education and career (1 = *start family sooner*, 9 = *further education and career*) on three items: "If you needed to choose, would you rather…, (a) get married sooner OR focus on your career;" (b) start a family sooner OR go to graduate school for many years to further your education;" and (c) have children sooner OR further your career." We averaged participants responses to these three items to form an index of their reproductive vs. somatic effort desire (α = .75). Scores below the midpoint of the scale (5.0) favored reproductive effort over somatic effort whereas scores above the midpoint of the scale favored somatic effort over reproductive effort.

Childhood SES. To assess objective childhood SES, participants were asked, "What was your monthly household income when you were growing up?" with 12 options (1 = *$1,000 or less*, 2 = *$1,000 - $1,999*, 3 = *$2,000 - $2,999*, 4 = *$3,000 - $3,999*, 5 = *$4,000 - $4,999*, 6 = *$5,000 - $5,999*, 7 = *$6,000 - $6,999*, 8 = *$7,000 -$7,999*, 9 = *$8,000 - $8,999*, 10 = *$9,000 - $9,999*, 11 = *$10,000 - $14,999*, 12 = *$15,000 or more*). The increased options compared to those in Study 1 allowed for greater variability. Participants also indicated agreement with three statements (1 = *strongly disagree,* 7= *strongly agree*): (a) "My family usually had enough money for things when I was growing up," (b) "I grew up in a relatively wealthy neighbourhood," and (c) "I felt relatively wealthy compared to other kids in my school," to assess subjective childhood SES (α = .88). Both SES indices were strongly correlated (r = .72); thus, we standardized them and created a childhood SES composite (α = .84).[2]

Finally, participants provided demographic information. They then received course credit and were debriefed.[3]

Results and discussion

Manipulation check

Childhood SES (z = -.20), desired timing of first child (z = -.50), reproductive timing attitude (z = .21), and tradeoffs (z = -.14) had acceptable levels of skewness; correlation and descriptive statistics can be found in Table 2, showing that the dependent variables are interrelated but still distinct.[4]

As intended, the economic uncertainty group perceived greater economic uncertainty ($M_{\text{Uncertainty}}$ = 5.07) than the control group (M_{Control} = 4.52), $t(121) = 2.24$, d _ 0.4, p = .03. Yet, participants in both groups reported similar positive ($M_{\text{Uncertainty}}$ = 2.67, M_{Control} = 2.83, $t(121)$ = -1.17, p = .24) and negative affect ($M_{\text{Uncertainty}}$ = 1.77, M_{Control} = 1.73, $t(121) = 0.26$, p = .78).

First, there was neither a main effect of participant sex, nor any interactions involving participant sex, on desired timing of first child (all ps > .29); male and female participants exhibited similar patterns of desired reproductive timing.

Desired timing of first child

We used multiple regression analyses to test for the two-way interaction between childhood SES and economic uncertainty (-1 = control, 1 = economic uncertainty) as predictors of desired timing of reproduction. There was a significant main effect of economic uncertainty, b = 0.56, $t(119)$ = 2.80, β = 0.24, p = .006; 95% CI [0.16, 0.95], such that participants in the economic uncertainty condition preferred a greater delay in reproduction, but no significant main effect of childhood SES, $b = 0.14$, $t(119) = .64$, $\beta = 0.06$, $p = .52$; 95% CI [-0.29, 0.57]. Moreover, consistent with hypotheses, there was also a significant childhood SES × economic uncertainty interaction, $b = 0.79$, $t(119) = 3.64$, $\beta = 0.31$, $p < .001$, $R^2 = 0.15$; 95% CI [0.36, 1.22].

As predicted, and consistent with Study 1 (see Fig. 2), individuals in the economic uncertainty condition who were raised in wealthier (versus poorer) childhood environments desired children significantly further in the future, $b = 0.93$, $t(119) = 2.83$, $p = .005$; 95% CI [0.28, 1.58]. Unlike in Study 1, however, individuals in the control condition who were reared in wealthier (versus poorer) childhood environments desired children significantly sooner in the future, $b = -0.65$, $t(119) = -2.28$, $p = .02$; 95% CI [-1.21, -0.09].

Test of simple slopes at high (+1 *SD*) and low (-1 *SD*) levels of childhood SES revealed that the individual simple slope indicating an effect of economic uncertainty was not significant for low-childhood SES individuals, $b = -0.18$, $t(119) = -0.62$, $p = .53$; 95% CI [-0.74, 0.39] but was significant for high-childhood SES individuals, $b = 1.28$, $t(119) = 4.58$, $p < .001$; 95% CI [0.72, 1.84].

Table 2
Correlations among variables and descriptive statistics, Study 2

Variable	1	2	3	4	5	Mean (SD)
1. Condition	-					0.00 (1.00)
2. Childhood SES	.06	-				0.00 (0.93)
3. Desired Timing of First Child	.24**	.03	-			7.27 (2.35)
4. Reproductive Timing Attitude	-.03	-.03	-.33**	-		3.29 (1.60)
5. Reproductive vs. Somatic Effort	-.01	-.06	.23**	-.47**	-	5.87 (1.88)

Note: ** $p < .001$. Condition was coded -1 for control and 1 for economic uncertainty.

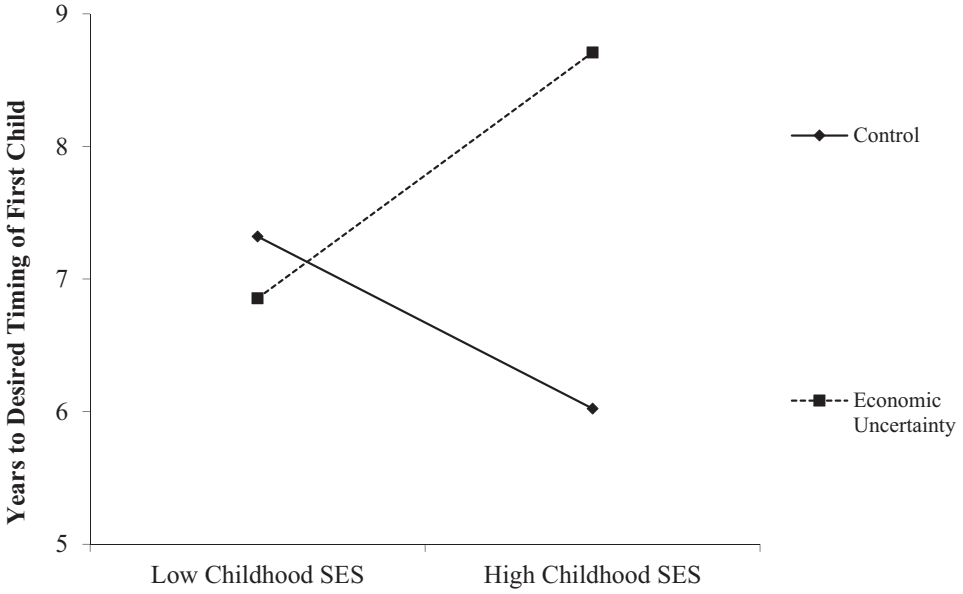

Fig. 2. Years to desired timing of first child as a function of childhood SES and economic uncertainty cues in Study 2.

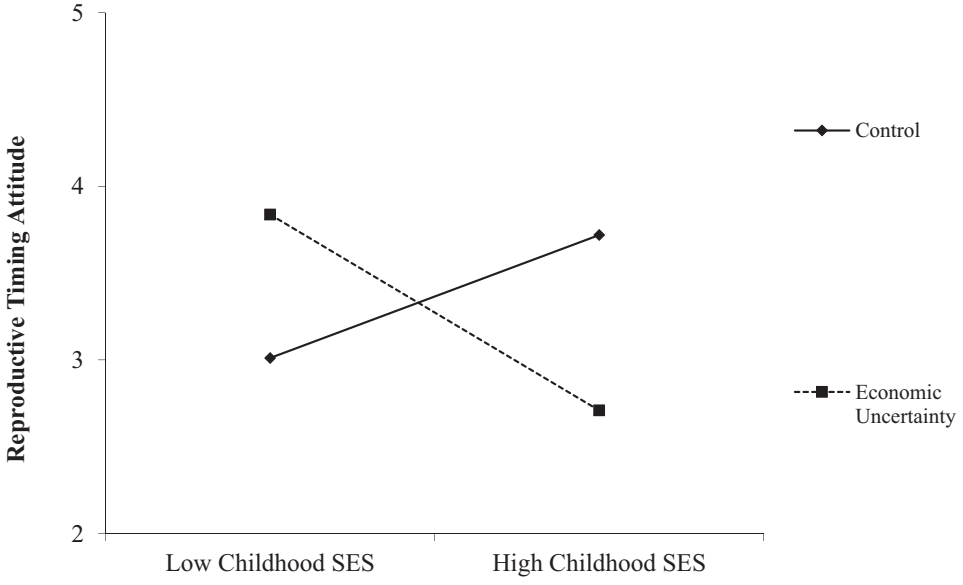

Fig. 3. Positivity towards having children sooner as a function of childhood SES and economic uncertainty cues in Study 2.

Reproductive timing attitude

For reproductive timing attitude, there were no significant main effects of economic uncertainty, b = -0.05, $t(119)$ = -0.32, β = -0.03, p = .75; 95% CI [-0.33, 0.23], or childhood SES, b = -0.11, $t(119)$ = -.68, β = -0.06, p = .50; 95% CI [-0.41, 0.20]. Consistent with hypotheses, however, there was a significant childhood SES × economic uncertainty interaction, b = -0.46, $t(119)$ = -2.96, β = -.26, p = .004, R^2 = 0.07; 95% CI [-0.76, -0.15].

As predicted (see Fig. 3), individuals in the economic uncertainty condition who were raised in wealthier (versus poorer) childhood environments had less positive attitudes towards having children sooner, b = -0.56, $t(119)$ = -2.41, p = .02; 95% CI [-1.02, -0.10]. However, individuals in the control condition who were reared in wealthier (versus poorer) childhood environments did not differ significantly in their attitudes toward having childreen sooner, b = 0.35, $t(119)$ = 1.74, p = .08; 95% CI [-0.05, 0.76].

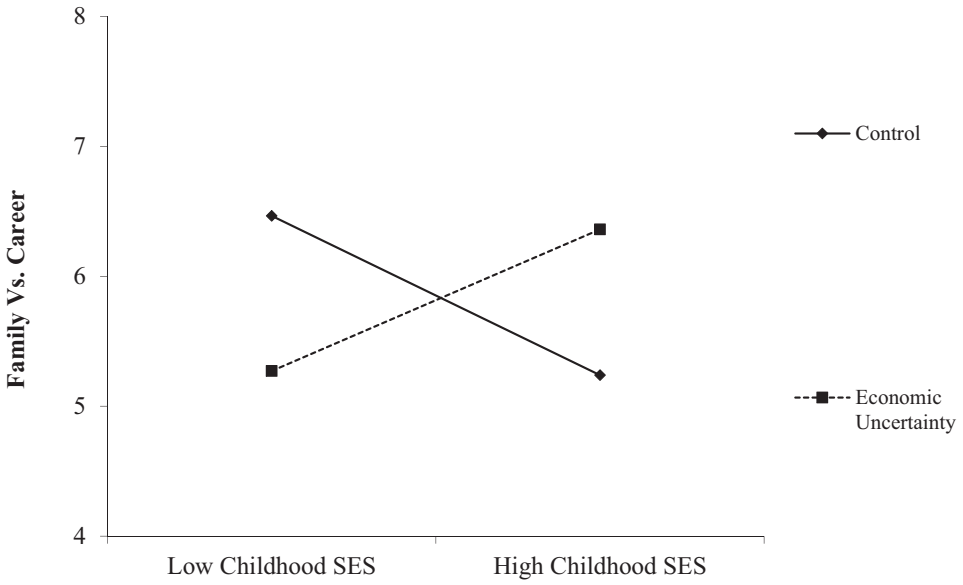

Fig. 4. The tradeoff between starting a family sooner versus investing in one's education and career (higher scores indicate focus on career) as a function of childhood SES and economic uncertainty cues in Study 2.

Test of simple slopes at high (+1 *SD*) and low (-1 *SD*) levels of childhood SES revealed that the individual simple slopes indicating an effect of economic uncertainty approached significance for low-childhood SES individuals, b = 0.37, $t(119)$ = 1.84, p = .06; 95% CI [-0.02, 0.78] and was significant for high-childhood SES individuals, b = -0.47, $t(119)$ = -2.35, p = .02; 95% CI [-0.87, -0.07].

Reproductive versus somatic effort

Finally, we investigated the effects of childhood SES and economic uncertainty on our proposed mediator—reproductive vs. somatic effort tradeoffs. There were no significant main effects of economic uncertainty, b = -0.02, $t(119)$ = -0.11, β = -0.01, p = .91; 95% CI [-0.34, 0.31], or childhood SES, b = -0.03, $t(119)$ = -0.19, β = -0.02, p = .85; 95% CI [-0.39, 0.32]. Consistent with our hypothesis, however, these non-significant main effects were qualified by a significant childhood SES × economic uncertainty interaction, b = 0.58, $t(119)$ = 3.22, β = 0.29, p = .002, R^2 = 0.08; 95% CI [0.22, 0.94].

As predicted (see Fig. 4), individuals in the economic uncertainty condition who were raised in wealthier (versus poorer) childhood environments more strongly favored furthering their career, b = 0.55, $t(119)$ = 2.00, p = .05; 95% CI [0.07, 1.08]. Conversely, individuals in the control condition who were raised in wealthier (versus poorer) childhood environments less strongly favored furthering their career, b = -0.61, $t(119)$ = -2.60, p = .01; 95% CI [-1.08, -0.15].

Test of simple slopes at high (+1 *SD*) and low (-1 *SD*) levels of childhood SES revealed that the individual simple slopes indicating an effect of economic uncertainty was significant for both low-childhood SES individuals, b = -0.56, $t(119)$ = -2.36, p = .02; 95% CI [-0.74, -0.39] and for high-childhood SES individuals, b = 0.52, $t(119)$ = 2.22, p = .03; 95% CI [0.06, 1.00].

In summary, Study 2 revealed that people's childhood environments interacted with current economic uncertainty cues to affect their reproductive timing in terms of desired timing to have a first child, timing attitude and tradeoffs. Consistent with hypotheses, individuals from wealthier (versus poorer) backgrounds reported relatively later desired reproductive timing when faced with economic uncertainty, but reported earlier reproductive timing in the control condition, with the exception of reproductive timing attitude, which merely approached statistical significance. Nonetheless, the general pattern of results was consistent with hypothesis.[5]

We then conducted a moderated mediation analysis (95% CI approach) to test the mediation of desired reproductive timing via reproductive vs. somatic effort desire using PROCESS Model 8 (Hayes, 2013), with childhood SES as the predictor and our economic uncertainty manipulation as the moderator. Bootstrapping results (10,000 resamples) indicated that the direct effect of the childhood SES × economic uncertainty interaction on reproductive timing attitude remained significant when we additionally controlled for reproductive vs. somatic effort desire, b = 1.34, p = .003. Furthermore, the mediating effect showed a 95% CI ranging from -0.02 to 0.58 for the indirect effect (0.23). Specifically, the conditional indirect effect was -0.12 [-0.32, 0.01] at control and 0.11 [-0.02, 0.33] at economic uncertainty. Inconsistent with hypothesis, childhood SES did not have a significant indirect effect on the desired timing of the first child through reproductive vs. somatic effort desire, albeit it was marginal.

We also similarly tested the mediation of reproductive timing attitude via reproductive vs. somatic effort desire using PROCESS Model 8 (Hayes, 2013), with childhood SES as the predictor and economic uncertainty manipulation as the moderator. Bootstrapping results (10,000 resamples) indicated that the direct effect of the childhood SES × economic uncertainty interaction on reproductive timing attitude became marginal once we controlled for reproductive vs. somatic effort desire, b = -0.49, p = .09. Furthermore, the mediating effect showed a 95% CI ranging from -0.67 to -0.19 for the indirect effect (-0.43). Specifically, the conditional indirect effect was 0.23 [0.09, 0.36] at control and -0.20 [-0.41, 0.01] at economic uncertainty. Consistent with statistical mediation, childhood SES had a significant indirect effect on reproductive timing attitude through reproductive vs. somatic effort desire, but only in the control condition and was marginally significant in the economic uncertainty condition.[6]

General discussion

We examined whether variability in reproductive timing and attitudes can be influenced by economic uncertainty. Results showed that the association between people's childhood environment and their desired reproductive timing depended on economic uncertainty cues in their current environments: When facing current economic uncertainty, individuals who grew up in resource-scarce (versus resource-abundant) environments reported more positive attitudes toward earlier reproductive timing and desired to have their first child sooner (i.e., faster life

history strategy). These findings were robust to two different measures of childhood SES: objective and subjective childhood SES.

Furthermore, we provided some insight as to why individuals differed in their reports of reproductive timing and replicated the key interaction between childhood environment and current economic uncertainty on life history tradeoffs. Individuals who grew up in resource-scarce (versus resource-abundant) environments reported preferring earlier reproduction to investing in education or work experience (i.e., faster life history strategy) when they faced current economic uncertainty. It should be noted that individuals with lower childhood SES still reported scores above the midpoint, indicating that they favored investing in education or work experience, albeit less strongly. Importantly, these tradeoffs regarding reproductive vs. somatic effort desire mediated the effect of economic uncertainty and childhood SES on reproductive attitudes.

A meta-analytic summary

The effect of economic uncertainty on reproductive timing was consistent across differing samples and varied measures of childhood SES. Nonetheless, due to sample size limitations and differing effect sizes, we sought to test the robustness of our effects. We conducted an integrative data analysis (IDA; Curran and Hussong, 2009), a technique that allows for primary or secondary analyses of data from multiple samples, in order to increase power and provide an overall test of hypotheses across datasets. To conduct the IDA, we standardized childhood SES within their respective sample, removing sample-level mean and variance differences, and controlled for study sample. We focused on the outcome variable of desired age of first child as that was the same construct across both studies.

There was no significant main effect of economic uncertainty, $b = 0.16$, $t(3851) = 1.28$, $p = .20$; 95% CI [-0.09, 0.41], no significant main effect of childhood SES, $b = 0.02$, $t(385) = .17$, $p = .87$; 95% CI [-0.24, 0.28], but a significant main effect of study, $b = -0.61$, $t(385) = -2.22$, $p = .03$; 95% CI [-1.15, -0.07]. Most important, consistent with hypotheses, there was a significant childhood SES × economic uncertainty interaction, $b = 0.30$, $t(385) = 2.30$, $p = .02$, $R^2 = 0.30$; 95% CI [0.04, 0.56].

Among participants in the economic uncertainty condition, those with higher (versus lower) childhood SESs desired children marginally significantly further in the future, $b = 0.32$, $t(385) = 1.72$, $p = .08$; 95% CI [-0.04, 0.69]; among participants in the control/economic certainty condition, we did not detect an association between childhood SES and desired reproductive timing, $b = -0.8$, $t(385) = -1.53$, $p = .13$; 95% CI [-0.64, 0.08]. Test of simple slopes at high (+1 *SD*) and low (-1 *SD*) levels of childhood SES revealed that individual simple slopes indicating an effect of economic uncertainty was not significant for low-childhood SES individuals, $b = -0.12$, $t(385) = -.69$, $p = .49$; 95% CI [-0.48, 0.23] but was significant for high-childhood SES individuals, $b = 0.46$, $t(385) = 2.57$, $p = .01$; 95% CI [0.11, 0.81]. In summary, the aggregated analysis show evidence in support of our predictions.

By examining economic uncertainty, we build on past work examining the effects of mortality cues and reproductive timing from a life history perspective (Griskevicius et al., 2011). Like mortality cues, economic uncertainty represents unpredictability and harshness in the environment—in this case, stemming from the lack of resources (Ellis et al., 2009). Both economic uncertainty and mortality threat manipulations are extrinsic stressors that signal current environmental threat, and although they have been shown to have similar effects across some outcomes such as impulsivity and risk-taking, this has yet to be examined for outcomes related to reproductive timing (Griskevicius et al., 2013; Griskevicius et al., 2011). Moreover, developed East Asian countries are facing especially low fertility rates, and modernization might make mortality cues less salient compared to economic uncertainty cues. Indeed, some research has shown that economic endeavors are especially prioritized over reproductive effort in developed East Asian countries (Yong et al., 2019). Hence, the current findings provide novel insights beyond past work, regarding the effects of economic uncertainty on whether and why people reared in wealthier (versus poorer) environments have children earlier versus later.

We found inconsistent effects in fertility expectations in our comparison conditions across both studies. Specifically, in Study 1, individuals who were raised in different childhood environments showed no differences in reproductive timing when facing economic *certainty*, replicating previous research suggesting that benign and safe environments might not elicit SES effects on life history strategies (Griskevicus et al., 2011; 2013). However, in Study 2, individuals raised in different childhood environments showed opposing effects in the control condition compared to the economic uncertainty condition. One possible explanation might lie in how risk preferences might change as a function of childhood environment and economic uncertainty (Nettle, 2009). Prior research shows that individuals raised in wealthier childhood environments express greater appetite for risks when there is no immediate threat (Griskevicius et al., 2011). It might be that, for our participants in the control condition, those raised in wealthier environments felt better able to risk earlier reproduction and cope with subsequent child rearing, whereas those raised in poorer environments preferred slightly less risk and focused on investing in somatic effort, especially so in a developed and urban environment such as Singapore. Future research could examine this idea more thoroughly. Regardless, what is key is that economic uncertainty elicited divergent life history strategies in terms of reproductive timing.

Implications

The current research has implications for various literatures. For instance, the findings help substantiate an evolutionary life-history mismatch perspective on reproductive decisions (Li et al., 2018). According to this perspective, humans have evolved mechanisms that take in environmental cues related to harshness and uncertainty and process them according to decision rules that produce output in the form of attitudes and behaviors regarding reproductive decisions. Although these decision rules, on average, led to adaptive decisions in the ancestral past, they are now processing evolutionarily novel inputs that may not have the same implications for reproductive fitness.

Importantly, because resource uncertainty may have had life-or-death consequences for offspring throughout human evolutionary history, mechanisms may have evolved to adaptively adjust reproductive strategies in response to cues of resource scarcity and uncertainty. As the current work suggests, even though the modern world is relatively safe and abundant, such mechanisms may nonetheless still be processing cues such as economic uncertainty. Combined with other evolutionarily novel features found in modern societies that may be similarly processed by reproductive mechanisms, such as enormously large population densities (Sng et al., 2018) and the insatiability of social status in an increasingly global world (Li et al. 2015; Yong et al., 2019), such cues may lead to a maladaptive slowing down of fertility to the point where local populations drastically shrink. Future research may benefit from investigating the extent to which these and other evolutionarily novel modern conditions (e.g., a lack of exposure to elements of nature that might signify safety and resource abundance in ancestral times; Li et al., 2018) may be contributing to the ultra-low fertility found in all East Asian countries, parts of Southeast Asia and Europe, and an increasing number of other modern societies.

Limitations and future directions

Although we consistently found moderating effects of economic uncertainty cues on the relationship between childhood SES and desired reproduction timing, there were minor limitations regarding our manipulations in Study 1 (i.e., status uncertainty and negative affect) that we tried to address in Study 2. It could also be noted that in spite of our

Study 2 manipulation being adapted from prior research (e.g., Griskevicius et al., 2010), the focal manipulation was about a contextual manipulation of uncertainty (unemployment) whereas the control condition was about an individual manipulation of uncertainty (losing one's wallet). Even though we are confident in the validity of our manipulations and results, future research could utilize more robust manipulations of uncertainty and ensuing comparisons to gain a better understanding of the effects of uncertainty on life history strategies.

Furthermore, the range of childhood SES from which we sampled was limited. University students typically are young and often come from middle- or upper-level SES backgrounds. Sampling from a wider range of childhood SES may uncover more powerful effects of childhood environment on reproductive timing. Nevertheless, the fact that we repeatedly found the moderating effect of economic uncertainty on the effects of perceived childhood SES suggests this effect may be quite robust in this population. Similarly, we sampled from a limited range of ages. Even though life history decisions in terms of reproductive timing are likely highly relevant to college-aged people, recruiting a sample that varies more in participant age might reveal potential boundary conditions of our effects. It should also be noted that our participant sample was largely female, but we did not find any gender main effects nor interactions with any of our findings. Importantly, our results regarding gender are consistent with prior life history research that examined the effects of mortality cues on reproductive timing and risk-taking, where mortality cues influenced men and women similarly and there were also no potential sex differences found on the main effect of reproductive timing as well (see Griskevicius et al., 2011; Griskevicius et al., 2011;). Nonetheless, we might not have had enough power to detect gender interactions because of our sample; future research should ensure a more equal representation between the sexes, even though we are relatively confident regarding the results that there are no potential sex differences.

In addition, our samples are from Singapore—a nation that is at or near the lowest nationwide fertility rate in the world and constitutes a cultural departure from typical psychology samples that examine Western, educated, industrialized, rich, and democratic (WEIRD) participants (Henrich et al., 2010) . On the other hand, college students in Singapore do fall into the categories of E, I, and R. Future research could collect more culturally diverse samples to extend the generalizability of our results. Finally, given the limitations of our student samples, it remains unclear the extent to which our outcome measures that focus on intentions (i.e., desired age of first child, reproductive timing attitude, reproductive vs. somatic effort desire) generalize to *actual* reproduction timing and behavior. After all, most young undergraduates have little to no experience with reproductive decisions, and intentions to reproduce might not translate to actual reproduction behavior in the general population. However, meta-analytic data suggest that intentions strongly predict actual behavior, in spite of an intention-behavior gap (Sheeran and Webb, 2016). Furthermore, given that reproduction is costly both biologically and in terms of opportunity for increasing embodied capital, it would be adaptive for one to first have reproductive intentions to aid planning and preparing for the arrival of future offspring. As such, we believe that reproductive timing intentions are frequently a precursor to actual reproductive behavior. Nonetheless, future research should prospectively examine the association between childhood SES, economic uncertainty, and actual reproduction behaviors.

We did not fully examine the proximate psychological processes underlying these divergent effects. Future research is needed to examine other possible mediators, such as sense of control. Recent research points to sense of control as a psychological driver of behaviors associated with different life history strategies (Mittal and Griskevicius, 2014), and so may help explain why environmental uncertainty alters the association between childhood environment and reproductive timing, as well as other related concepts such as risk-taking and valuation of quantity versus quality (Griskevicius et al., 2013; White et al., 2013). Given that conditions of uncertainty are associated with less control, fast strategists may respond by prioritizing immediate reproductive efforts, which includes taking more risks for larger immediate payoffs and having children sooner (Mittal and Griskevicius, 2014). Conversely, slow strategists may respond by prioritizing somatic effort in an effort to regain the sense of control they are used to. Sense of control might also be related to optimism or confidence about abilities to deal with economic uncertainty, and results in the adoption of faster or slower life history strategies (Mittal and Griskevicius, 2014). Future research is needed to ascertain if sense of control or optimism are indeed mediating variables in the relationship between economic uncertainty and reproductive timing. One might also examine mortality thoughts that could arise from economic uncertainty, as resource scarcity could represent cues of unpredictability and harshness in ancestral environments (Griskevicius et al., 2013).

Finally, the link between economic uncertainty and fertility is particularly relevant in current times, given the coronavirus-19 pandemic and its influence on economic uncertainty and instability (see Fernandes, 2020). Future research can fruitfully investigate how variables such as disease prevalence—which has been shown to be linked adaptively to cross-cultural differences in personality traits (Schaller and Murray, 2008)—and economic uncertainty interact and influence reproductive timing mechanisms.

Conclusion

The current research sheds some light on and adds to the literature addressing the changing patterns in human fertility cycles and family size (e.g., Borgherhoff-Mulder, 1998; Hill and Reeve, 2004; Nolin and Ziker, 2016). Our findings suggest a way of reconciling how individuals across a range of early childhood environments utilize fast versus slow life history strategies to adapt to present-day economic uncertainty cues in terms of their desired reproductive timing—a potentially major determinant of individuals' actual reproduction and hence, the fertility rates we observe across nations. The current research highlights the benefits of utilizing an evolutionary perspective and sets the stage to design potential interventions such as increasing or decreasing personal control (Mittal and Griskevicius, 2014), potentially altering life history trajectories, and thereby modifying fertility patterns and family sizes.

Footnotes

[1]All data, materials and code can be requested from the first author.

[2]Childhood SES did not differ as a function of the manipulation in both studies.

[3]Models controlling for PA and NA yielded results that essentially showed that associations did not change in direction nor significance. Models separating subjective and objective SES also yielded results that replicated the same pattern of results as our combined SES measure.

[4]It is possible that reproductive timing attitude and reproductive vs. somatic effort desire might be the same construct, given their high correlation with one another. To evaluate the dimensionality of the items administered to assess reproductive timing attitude and reproductive vs. somatic effort desire, we conducted an exploratory factor analysis on the six total items intended to tap these two constructs using a maximum likelihood estimate and direct oblimin rotation. Based on eigenvalue and scree plot analysis, two factors were found to underlie the items, accounting for 59.24% of the variance. Further examination of the rotated factor loadings showed that there were no meaningful cross loadings between the items intended to measure the two constructs.

[5]It could be possible that there was a failure in random assignment given that there were significant differences in the control condition. However as mentioned in Footnote 2, there were no significant differences in the means of childhood SES between both conditions, and random assignment successfully created groups that were equal on our key moderator.

[6]Utilizing $CI_{90\%}$ for our moderated mediation model showed that childhood SES had significant indirect effects on the desired timing of

the first child as well as on reproductive timing attitude through reproductive vs. somatic effort desire.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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