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# Childhood unpredictability, life history, and intuitive versus deliberate cognitive styles

Xinrui Wang, Nan Zhu, Lei Chang *

*Department of Psychology, University of Macau, Taipa, Macao*

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ABSTRACT

Cognitive style is a major component of individuals' life history and everyday life. However, individual variations in cognitive styles are not well understood from an evolutionary functional perspective. Through two studies, we investigated how childhood unpredictability might be related to deliberate or intuitive cognitive styles. Study 1, in which we surveyed 301 undergraduate students, revealed that lower childhood unpredictability was a predictor of slower life-history strategies, and such strategies in turn predicted higher self-reported deliberate cognitive style. In Study 2 ($N = 269$), we experimentally manipulated mortality cues and subsequently assessed participants' deliberate responses by using the Cognitive Reflection Test. The results indicated that individuals who experienced higher childhood unpredictability, relative to those who had low childhood unpredictability, displayed a smaller proportion of deliberate responses when exposed to mortality cues but not when exposed to control cues. These results imply that childhood unpredictability might predispose individuals to specific cognitive styles that serve distinct adaptive functions. This is manifested as both long-term propensities in life-history development and short-term behavioral tendencies in threatening situations.

## 1. Introduction

Dual-process theories of cognition identify two types of cognitive processes: (1) intuitive processes, which are characterized as automatic, affect-based, and effortless, and (2) deliberate processes, which are regarded as conscious, analytic, and effortful (Evans & Stanovich, 2013; Kahneman, 2003). Theorists argued that individuals face a trade-off between effortless intuitive processes and costly deliberate processes (Evans & Curtis-Holmes, 2005; Keramati et al., 2011; Paxton & Greene, 2010). Research has consistently revealed individual differences in the preference for intuitive or deliberate cognitive processes (Frederick, 2005; Kokis et al., 2002; Shiloh et al., 2002). Such individual preferences in processing information are called cognitive styles (Cools & Van den Broeck, 2007). However, why cognitive styles vary between people is not well understood. Moreover, individual differences in cognitive styles, as reflected in various cognitive tasks, might be contingent on certain situations (Mittal et al., 2015). From an evolutionary perspective, we propose that such variations in cognitive styles and their behavioral manifestations are ultimately related to adaptive trade-offs in cognitive resource expenditures that are calibrated in individuals' early environments.

The trade-offs in cognitive resource expenditure likely follow the principle of life-history trade-offs (Richardson & Hardesty, 2012). Evolutionary life history theory describes how gene-by-environment interactions maintain genetic variances and shape phenotypic plasticity in the allocation of somatic and reproductive efforts to shape life spans, growth patterns, and organisms' behaviors between and within species (Stearns, 1989; Woodley of Menie et al., 2021). Within-species variations in life history phenotypes can be seen as resulting from trade-offs between different components of fitness happening at genotypic, phenotypic, or intraindividual levels such as the trade-off between the reproductive investment and the survival of the organism (Stearns, 1989). The adaptive resolutions of such trade-offs are called "life-history strategies", which are commonly conceived as varying along a fast-slow continuum (Promislow & Harvey, 1990). Variations in life-history strategies are also reflected in diverse psychological and behavioral aspects of human life. For instance, fast strategists tend to be present-oriented and prone to risk-taking. By contrast, slow strategists tend to be future-oriented and risk-averse (Chen & Chang, 2016; Kruger et al., 2008; Mishra et al., 2017).

* Corresponding author at: Department of Psychology, Humanities and Social Sciences Building E21-3045, University of Macau, Avenida da Universidade, Taipa, Macao.

*E-mail addresses:* yb77303@um.edu.mo (X. Wang), darrenzhu@um.edu.mo (N. Zhu), chang@um.edu.mo (L. Chang).

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Although both genes and environments play crucial roles in shaping human life-history profiles (Figueredo et al., 2006), the current research is mainly concerned with the environmental effects, especially those of early adversities, on the calibration of individuals' life-history strategies (Ellis, 2004). In unpredictable environments, fast life-history strategies are advantageous because they serve to maximize early reproduction in an effort to escape morbidity or mortality. By contrast, slow life-history strategies are preferred in safe and stable environments where investments in parenting and offspring quality at the cost of delayed reproduction, tend to be worthwhile.

Unpredictability experienced in childhood has a far-reaching influence on the development of life-history strategies (Amir et al., 2016; Ellis et al., 2009; Simpson et al., 2012). Experiences in the early years of life may serve as cues for behavior in future environments (Belsky et al., 1991, 2012). Children growing up in unpredictable environments might calibrate their life-history strategies in anticipation of a similar adulthood environment. Indeed, early adversity has been linked to physiological and behavioral signs of fast strategies: early adversity might accelerate girls' menarche, sexual debut, and first pregnancy (Quinlan, 2003), and lead to increased impulsive and risky behaviors in adulthood for both sexes (Lovallo, 2013). Adverse childhood environments might also impair individuals' physical health. This impairment might act as an internal signal that prompts accelerated growth to avoid morbidity or mortality before reproduction (Chua et al., 2017; Rickard et al., 2014). An empirical study revealed that childhood harshness and unpredictability, mediated by childhood health quality, predicted more risky and problematic behaviors and an earlier age of menarche (Hartman et al., 2017). The aforementioned studies suggest that childhood unpredictability plays a pivotal role in shaping individuals' life-history strategies in adulthood.

Together with social and relationship manifestations, cognitive processes constitute a crucial part of human life-history strategies (Del Giudice & Crespi, 2018; Figueredo et al., 2012; Wenner et al., 2013). Woodley (2011) proposed that life-history speed may be linked with different types of cognitive efforts, which may contribute to genetic variance in intelligence. Specifically, he argues that slow life histories are associated with greater cognitive differentiation efforts which allow individuals to better adapt to stable ecological niches via increased specialization. Fast life histories, by contrast, are associated with cognitive integration efforts, which permit individuals to deal with wider ranges of micro-niches in an unstable environment (Woodley, 2011). This view highlights the possibility that life-history tradeoffs might maintain individual differences in cognitive styles that are favored by different environments. Other researchers suggest that general cognitive abilities such as intelligence should be correlated with substantial somatic efforts, an extended lifespan, and strong future orientations that are supportive of the development of a large brain (Kaplan et al., 2000; Rushton, 2004). These cascades of human development, especially with encephalization, all characterize a slow life-history. Empirical evidence confirms the positive association between slow life-history strategies and intelligence (Dunkel et al., 2021). Given that high intelligence might promote the use of a more deliberate and computationally demanding cognitive strategy in decision-making (Maran et al., 2020), slow strategists are likely to show a preference for deliberate cognitive styles.

Whether to adopt an effortless, intuitive cognitive style or a costly, deliberate cognitive style is an adaptive problem that might be influenced by an individual's early environments. According to the default-interventionist model, when confronting a problem, individuals tend to first automatically generate an intuitive response. Subsequently, a deliberate response may be generated if additional cognitive resources are used to override the initial response (Evans & Stanovich, 2013). Individuals who experienced childhood adversity, however, might be predisposed to diverting cognitive resources to more urgent needs, and thus they lack extra cognitive resources necessitated by deliberative processes. Indeed, abundant research supports the notion that childhood adversity tends to impair human cognitive functions (Bauer et al., 2009; Fox et al., 2010; Mueller et al., 2010). For example, children who experienced institutionalized rearing, which is a relatively deprived environment, might have deficits in executive functioning (Bos et al., 2009; Hostinar et al., 2012; Merz & McCall, 2011) that is essential for everyday life. Inhibitory control, for example, as a central component of executive functioning, is critical for resisting heuristic responses to engage in deliberate thinking in reasoning (Andersson et al., 2019; Carriedo et al., 2020), as well as suppressing distractors and focusing on goals in goal-directed activities (Tiego et al., 2018). Deficits in inhibitory control impair not only performances in non-social cognitive tasks but also social cognitive functioning such as theory of mind (Carlson et al., 2004) and academic performance (Jaekel et al., 2016). Further, Zhu et al. (2018) reported that stressful events in early life were negatively associated with rational moral judgments, which rely on deliberate cognitive processes through perspective-taking. Therefore, unpredictable, adverse upbringings seemed to be associated with a preference for intuitive processes, which tend to prioritize immediate returns but at the cost of long-term personal development.

Unlike intuitive processes, deliberate processes are time-consuming and burden limited cognitive resources such as working memory (Barrett et al., 2004; Evans & Stanovich, 2013; Jiménez et al., 2017). However, deliberate cognitive activities, such as deep thinking and thorough information searching, are crucial for gaining knowledge that benefits individuals in the future (Sih & Del Giudice, 2012; Waller, 1999). Deliberate processes also underpin future-oriented behaviors, such as planning and self-regulation (Barkley, 2001). Hence, individuals who developed in stable environments, which allow people to expect returns from future-oriented investment, should exhibit more deliberate responses.

Prolonged exposure to unpredictable or predictable environments might change the expected utility of intuitive and deliberate processes in later life. For fast strategists who grew up in unpredictable environments, a stronger intuition that enables individuals to grasp fleeting chances and react rapidly to threats is more adaptive (Ellis et al., 2017). Such abilities are required for survival and seizing reproductive opportunities and might be prioritized in constantly changing environments with high mortality threats. Under constant environmental stress, somatic efforts might be diverted away from time-consuming and effortful cognitive functions like planning and inhibitory control that support deliberate cognitive processes (Del Giudice & Crespi, 2018; Figueredo et al., 2012; Teicher et al., 2016). In other words, a preference for intuitive cognitive processes over deliberative cognitive processes, although not a voluntary choice, may be adaptive in threatening environments. For slow strategists who grew up in stable environments, however, future-oriented planning based on deliberation might be deemed considerably more valuable than impulsive decision-making based on intuition (Figueredo et al., 2005). Eventually, fast (slow) life-history strategies, which are associated with unpredictable (predictable) childhood experiences might be responsible for the formation of a relatively stable intuitive (deliberate) cognitive style. The first goal of this research, therefore, was to investigate the mediating effect of life-history strategies on the relationship between childhood unpredictability and young adults' explicit endorsement of intuitive versus deliberate cognitive styles.

Although people who experienced childhood adversity might have developed a preference for a less deliberate cognitive style, this preference might not necessarily translate into intuitive behavioral tendencies in all situations. For instance, some studies have found no correlation between the threat dimension of childhood adversity, operationalized as physical or sexual abuse and exposure to domestic or neighborhood violence, and inhibitory control (Augusti & Melinder, 2013; Lambert et al., 2017; Sheridan et al., 2017). These findings do not necessarily contradict the notion that the trade-off between intuitive and deliberate cognitive styles is ultimately linked to experiences of childhood adversity. People with unpredictable childhood experiences do not necessarily consistently rely on intuitive responses. Rather, they might prefer intuitive responses to a greater degree than do people with stable childhood experiences in situations where such preference is likely adaptive (e.g., when confronting mortality threats that cannot be rejected through deliberate thinking).

This leads us to propose that the manifestation of intuitive or deliberate cognitive styles in behavioral responses might be a function of childhood experiences, situational threats, and their interaction. Some experimental evidence supports this extrapolation. Mittal et al. (2015) reported that, compared with individuals with a stable childhood, only when exposed to uncertainty cues did individuals with an unpredictable childhood display superior cognitive shifting (switching to other tasks), and they exhibited poorer cognitive inhibition. Similarly, studies have revealed that experimentally primed mortality cues prompted individuals who experienced higher childhood unpredictability to be more impulsive, which indicates a greater desire for immediate rewards and earlier reproduction timing. By contrast, exposure to mortality cues induced individuals who experienced lower childhood unpredictability to be less impulsive, preferring delayed rewards (Griskevicius et al., 2013; Griskevicius, Tybur, et al., 2011). Therefore, another goal of the present research was to investigate the combined effects of childhood unpredictability and experimentally manipulated mortality cues on participants' behavioral manifestation of intuitive versus deliberate cognitive styles.

In the present research, we first examined the associations among childhood unpredictability, life-history strategies, and self-reported cognitive styles by employing a survey (Study 1). Subsequently, we explored whether childhood unpredictability and current mortality cues would jointly predict the cognitive styles that individuals exhibit in problem-solving behaviors (Study 2). We hypothesized that individuals who grew up in environments with lower unpredictability would develop slower life-history strategies and a higher preference for deliberate processes than would individuals who grew up in environments with higher unpredictability. In Study 2, we introduced a priming paradigm to manipulate mortality threats. Individuals' performance in the Cognitive Reflection Test (CRT; Frederick, 2005) was used to indicate behavioral manifestations of intuitive versus deliberate cognitive styles. To provide correct responses in the CRT, one needs to override an intuitive but incorrect reaction. This reflects inhibitory control that is a key component of deliberate cognitive process. We hypothesized that in the condition with mortality priming, individuals with higher childhood unpredictability would perform poorer on the CRT (indicating less deliberate cognitive responses) than would individuals with lower childhood unpredictability. In the condition without mortality cues, childhood unpredictability would not have a salient effect on individuals' performance in the CRT.

## 2. Study 1

### 2.1. Method

#### 2.1.1. Participants

Participants were 301 undergraduate students (32.6% male, 18 to 24 years old, $M = 19.83$ years, $SD = 1.42$ years) from a public university in Macau, China. Ethics approval was obtained from the university. Our sample size was supported by the rules of having sufficient cases per observed variable (Nunnally, 1967). A sensitivity power analysis using G*Power 3.1 (Faul et al., 2007) revealed that using the current sample size, the minimal effect size that could be detected ($\alpha \leq 0.05$, statistical power $\geq 0.80$) corresponded to a Critical $t = 1.97$, which was lower than *ts* that were obtained in this study.

#### 2.1.2. Measurements

Childhood unpredictability was measured by three retrospective questions that were used in previous research (i.e. "When I was younger than 10: (a) things were often chaotic in my house, (b) people often moved in and out of my house on a pretty random basis, and (c) I had a hard time knowing what my parent(s) or other people in my house were going to say or do from day-to-day"; Mittal et al., 2015). These items were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicate higher levels of experienced childhood unpredictability. The alpha coefficient was 0.58. The relatively low alpha coefficient reported here is in part due to a small number of items (Vaske et al., 2017).

The K-SF-42, a recently developed short form of the Arizona Life History Battery (Figueredo et al., 2017), was used to measure participants' life-history strategies. The scale contains 7 subscales: Insight, Planning, and Control (e.g., "Once I make a plan to get something done, I stick to it"), Romantic Partner Attachment[1] (e.g., "I worry that my romantic partner won't care about me as much as I care about him/her"), General Altruism (e.g. "I spend a great deal of time per month doing formal volunteer work at school or other youth-related institution"), Religiosity (e.g. "Religion is important in my life"), Parental Relationship Quality (e.g., "While you were growing up, your mother/father gave you time and attention when you needed it"), Family Contact and Support (e.g. "Your relatives helped you get worries off your mind"), and Friends Contact and Support (e.g. "Your friends helped you get worries off your mind"). Participants answered the questions on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) for the first four subscales and on a 4-point scale ranging from 1 (*not at all*) to 4 (*a lot*) for the last three subscales. Because most of the participants were nonreligious, the religiosity subscale was excluded from the analyses. A composite of the remaining 36 items was used to measure the construct with a higher score indicating slower life-history strategies. The alpha coefficient was 0.89.

The 9-item deliberation subscale of the Preference for Intuition and Deliberation Scale (PID, Betsch & Kunz, 2008) was used to measure participants' tendency to think deliberately and analytically rather than intuitively and rashly in decision-making (e.g. "When I have a problem, I first analyze the facts and details before I decide"). Participants rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores indicated a stronger preference for deliberate against intuitive cognitive style. The alpha coefficient was 0.91.

Participants rated their subjective socioeconomic status (SES) relative to other people in their city on a 10-rung ladder from 1 (*the lowest SES*) to 10 (*the highest SES*) (Adler et al., 2000). We also obtained participants' grade point average (GPA) of the previous semester.

### 2.2. Results and discussion

Descriptive statistics and correlations among research variables were presented in Table 1. We found that childhood unpredictability was negatively correlated with slow life-history strategies and deliberate cognitive style. Slow life-history strategies were positively correlated with deliberate cognitive style. Participants' sex, age, subjective SES, and GPA were controlled in subsequent analyses.

We examined the mediating effect of slow life history strategies on the relationship between childhood unpredictability and the deliberate cognitive style using model 4 of the SPSS PROCESS macro (Hayes, 2017). As presented in Fig. 1, after sex, age, SES, and GPA were controlled, childhood unpredictability was negatively associated with slow life-history strategies ($\beta = -0.24$, $t = -4.18$, $p < .001$), which, in turn, were positively associated with deliberate cognitive style ($\beta = 0.27$, $t = 4.31$, $p < .001$). The direct effect of childhood unpredictability on deliberate cognitive style was not significant in the model ($\beta = -0.10$, $p = .104$). The mediation effect of slow life-history strategies on the relation between childhood unpredictability and deliberate cognitive style was significant (standardized indirect effect = −0.07,

[1] Participants would evaluate their relationships with an important other in their life if they did not have romantic relationship experience.

**Table 1**
Descriptive statistics and correlations among variables in Study 1 ($n$ = 301).

| | $M$ | $SD$ | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1. CU | 1.77 | 0.69 | – | | | | | |
| 2. Slow LHS | 3.55 | 0.53 | −0.30*** | – | | | | |
| 3. DCS | 4.04 | 0.77 | −0.17** | 0.33*** | – | | | |
| 4. SES | 5.68 | 1.38 | −0.22*** | 0.35*** | 0.23*** | – | | |
| 5. GPA | 3.06 | 0.56 | −0.06 | 0.11 | 0.14* | 0.19** | – | |
| 6. Age | 19.83 | 1.42 | 0.06 | −0.10 | −0.14* | −0.15* | −0.13* | – |
| 7. Sex | | | 0.00 | 0.08 | 0.01 | 0.05 | 0.13* | −0.26*** |

Note: CU = childhood unpredictability, Slow LHS = slow life history strategies, DCS = deliberate cognitive style.
* $p < .05$
** $p < .01$.
*** $p < .001$.

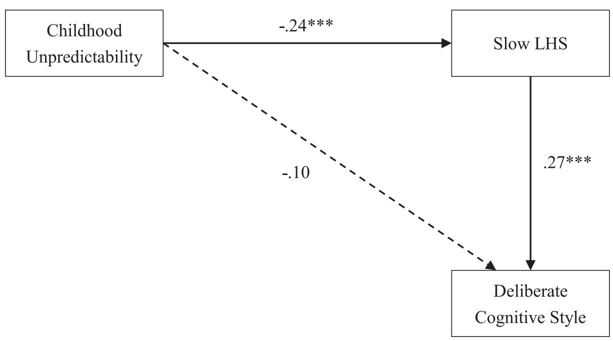


**Fig. 1.** Study 1: Standardized regression coefficients among childhood unpredictability, slow life-history strategies, and deliberate cognitive style. The dashed line indicates that the path was not significant after slow LHS mediation. ***$p < .001$.

95% confidence interval (CI) [−0.11, −0.03], estimated through corrected bootstrap analyses with 10,000 resamples).

Results in Study 1 revealed that low childhood unpredictability was associated with slow life-history strategies, which, in turn, was associated with a preference for deliberate decision-making. Slow strategists prefer spending more time and energy on garnering information for accurate decision-makings. This tendency is adaptive in predictable environments where such cognitive efforts serve as prospective investments that are likely to pay off. However, as argued before, the effects of childhood unpredictability on individuals' behavioral performance in cognitive tasks might be contingent on unpredictability cues (Young et al., 2018). To address the possible interaction between childhood unpredictability and situational cues on behaviorally exhibited intuitive versus deliberate cognitive styles, we designed Study 2. In Study 2, the CRT was introduced as an indicator of whether individuals would behaviorally display an intuitive or a deliberate cognitive style. We also used a different measure of childhood unpredictability with more items and better internal consistency than the three-item scale used in Study 1.

## 3. Study 2

### 3.1. Method

#### 3.1.1. Participants

Two hundred and sixty-nine participants (46.1% male, 18 to 60 years, $M$ = 30.99, $SD$ = 7.35) were recruited through the Chinese survey website WJX (https://www.wjx.cn), in June 2020. Participants were randomly assigned to an experimental condition with mortality cues ($n$ = 124) and a control condition with non-mortality cues ($n$ = 145). Ethics approval was obtained from the first author's university. A sensitivity power analysis using G*Power 3.1 (Faul et al., 2007) revealed that using the current sample size, the minimal effect size that could be detected ($\alpha \leq 0.05$, statistical power $\geq 0.80$) corresponded to a Critical $t$ = 1.97, which was lower than the $t$ of interaction in this study.

#### 3.1.2. Priming materials

Participants were asked to read and evaluate a short article ostensibly as a pilot test of reading materials for research. After reading the material, they were asked to evaluate the reading difficulty of the material (i.e. "I think the passage is easy to understand") on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*).

Participants in the experimental condition read an article about the COVID-19 casualties and social turmoil during the pandemic. Participants in the control condition read a short article about the definition and the negative consequence of perfectionism. The two articles were of similar lengths (246 and 247 Chinese characters for the experimental and control articles, respectively). The comparison of reading difficulty revealed no difference between the experimental ($M$ = 4.35, $SD$ = 0.61) and control ($M$ = 4.30, $SD$ = 0.71) materials, $t(267) = 0.62$, $p$ = .538.

#### 3.1.3. Measurements

The three-item CRT (Frederick, 2005) was used to measure the deliberate effort to overcome an intuitively predominant but incorrect response, in order to reach the correct answer. Specifically, participants needed to solve seemingly simple but potentially misleading math problems and fill their answers in the blank, an example being "A bat and a ball cost ¥11 in total. The bat costs ¥10 more than the ball. How much does the ball cost? ____yuan." There was no time constraint in responding to these questions. The intuitive but incorrect answer for this question is "1 yuan", while the correct answer should be "0.5 yuan". The number of correct answers, intuitive answers, and other incorrect answers (like "10 yuan" for the example item), were calculated for each participant. The number of correct answers (referred to as CRT-C) was used as the dependent measure indicating deliberate responses.

To assess childhood unpredictability, in addition to the three items used in Study 1, three items from the Confusion, Hubbub, and Order Scale (Matheny et al., 1995, e.g. "I often get drawn into other people's arguments at home") and four items adopted from the neighborhood subscale of People in My Life Questionnaire (Murray & Greenberg, 2006, e.g. "My neighborhood is a dangerous place to live") were added. Participants rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) how much these 10 items reflected their childhood experience prior to 10 years of age. A higher mean score indicated higher levels of childhood unpredictability. The alpha coefficient for this 10-item measure was 0.80. Childhood unpredictability did not differ between the experimental ($M$ = 1.86, $SD$ = 0.54) and control ($M$ = 1.86, $SD$ = 0.48) conditions, $t(267) = -0.10$, $p$ = .918.

Five questions measuring participants' current perceived unpredictability (e.g. "I think today's world is unpredictable") were used to evaluate the effect of experimental manipulation (Griskevicius, Delton, et al., 2011). Participants rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A higher mean score indicated higher currently perceived unpredictability. The alpha coefficient was 0.66. Participants in the experimental condition ($M = 3.28$, $SD = 0.67$) reported significantly higher perceived unpredictability than participants in the control condition ($M = 3.07$, $SD = 0.72$) did, $t(267) = 2.51$, $p = .013$, which indicated that the priming material about the pandemic of COVID-19 indeed induced individuals' feeling of unpredictability.

#### 3.1.4. Procedure

Participants first read and evaluated the priming material. This is followed immediately by the CRT. Finally, participants answered childhood unpredictability and manipulation check questions.

### 3.2. Results and discussion

The proportions of correct, intuitive, and other incorrect responses are shown in Table 2. Participants in the experimental ($M = 1.83$, $SD = 1.10$) and control conditions ($M = 1.86$, $SD = 1.10$) showed no difference in CRT-C, $t(267) = -0.18$, $p = .855$.

The moderating effect of priming conditions (represented by a dummy variable coded as 0 = *Control condition*, 1 = *Experimental condition*) on the relationship between childhood unpredictability and CRT-C was tested through model 1 of PROCESS macro (Hayes, 2017) with 95% CI estimated through bias-corrected bootstrap analyses with 10,000 resamples. Results showed that the interaction of childhood unpredictability and conditions on CRT-C was significant ($B = -0.55$, $p = .038$, 95% CI [−1.06, −0.03], Fig. 2). In the Control Condition, childhood unpredictability and CRT-C were unrelated ($B = 0.15$, $t = 0.81$, $p = .419$, 95% CI [−0.22, 0.52]). Whereas in the experimental condition, higher childhood unpredictability predicted lower CRT-C ($B = -0.39$, $t = -2.17$, $p = .031$, 95% CI [−0.75, −0.04]).

These results indicated that the effects of childhood unpredictability on individuals' behavioral manifestations of deliberate (versus intuitive) cognitive style were contingent on unpredictability cues. In the face of environmental unpredictability, individuals who experienced a highly unpredictable childhood were more likely to follow their intuition and less likely to engage in deliberation, compared with individuals who experienced a stable childhood. This pattern was not observed when there was no cue of mortality threats.

## 4. General discussion

This study investigated the relationships among childhood unpredictability, life-history strategies, and intuitive versus deliberate cognitive styles. Study 1 indicated that low childhood unpredictability was predictive of slow life-history strategies, which in turn predicted a higher preference for deliberate cognitive style. Study 2 revealed that individuals' behavioral manifestations of deliberate versus intuitive cognitive style were influenced by the interaction between childhood unpredictability and situational unpredictability cues.

Consistent with previous research (e.g., Chang et al., 2019; Chen et al., 2017; Lu & Chang, 2019), we found that higher levels of childhood unpredictability were predictive of faster life-history strategies. This finding is not only supported by evolutionary theories but also consistent with numerous empirical findings in the past few decades. Natural selection favors the calibration of life-history strategies to people's developmental environments (Ellis, 2004). Childhood unpredictability serves as a crucial driving force in this calibration process. For

**Table 2**
Study 2: Proportions of correct, intuitive, and other incorrect responses in the CRT.

| Condition | Proportion of responses | | |
|---|---|---|---|
| | Correct | Intuitive | Other Incorrect |
| Experimental | 61% | 29% | 10% |
| Control | 62% | 30% | 8% |

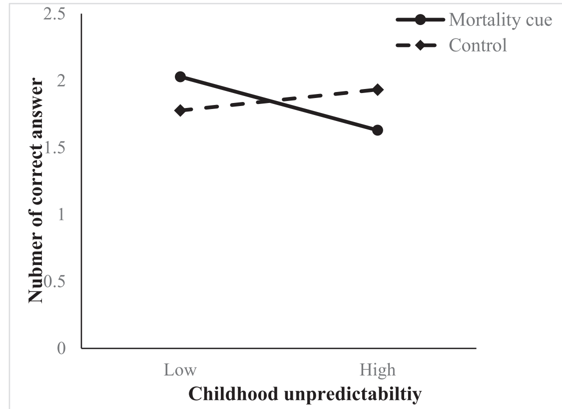


**Fig. 2.** Study 2: CRT-C as a function of childhood unpredictability and experimental conditions. Low and high childhood unpredictability represented one standard deviation above and below the mean of childhood unpredictability.

individuals confronting unpredictable extrinsic morbidity–mortality risks in their childhood, accelerated life-history strategies might increase the likelihood of surviving to reproduction (Ellis et al., 2009). By contrast, for individuals who develop in stable environments, planning and preparing for the future might be more adaptive than focusing on the present would be (Chen & Kruger, 2017; Gladden et al., 2009). Research has revealed that childhood unpredictability induces earlier sexual maturation as well as intention of and engagement in earlier reproduction (Clutterbuck et al., 2014; Ellis & Essex, 2007; Patch & Figueredo, 2017). The current findings suggest that lower childhood unpredictability leads to slower life-history strategies, which might manifest as a preference for the deliberate cognitive style.

We found a positive association between slow life-history strategies and a deliberate cognitive style. This is consistent with previous research that linked fast life-history strategies to impulsivity (Copping et al., 2013) and lack of cognitive and behavioral control (Figueredo et al., 2012; Wenner et al., 2013). One plausible reason for this finding is that effortful, controlled cognitive processes are conducive to future reproductive success, which is prioritized by slow strategists (Figueredo et al., 2012; Warren & Barnett, 2020) in safe and stable environments. Moreover, inhibited impulsivity and resistance to immediate rewards, which characterize the deliberate cognitive style, would reduce chances for immediate reproductive success, which is prioritized by fast strategists. For fast strategists, an intuitive cognitive style that avoids time-intensive reflection and enables them to rapidly shift to more pressing objectives might be advantageous. Such advantages might be particularly salient in threatening situations when the cost of overthinking and hesitation is substantially higher than the cost of intuitive and inaccurate decisions.

This possibility was particularly addressed in Study 2. Our findings indicate an interaction between situational mortality cues and childhood unpredictability in individuals' performance on the CRT, which can be regarded as a behavioral manifestation of their cognitive style. Specifically, when mortality cues were present, individuals with lower childhood unpredictability provided more correct answers than did individuals with higher childhood unpredictability. When mortality cues were absent, childhood unpredictability did not affect CRT performance. These results are consistent with previous findings (e.g., Mittal et al., 2015) that childhood adversity does not universally impair individuals' cognitive functioning. This adversity actually enhanced the executive function of shifting (flexibly switching between different tasks) in uncertain situations. Therefore, a more plausible interpretation of our findings is that individuals who experienced high childhood unpredictability were not necessarily incapable of deliberation. Rather, they might have learned or unconsciously become conditioned to a strategy of dedicating less time and effort to cognitive tasks in order to save energy for more urgent tasks when faced with environmental cues confirming their anticipation of an unpredictable future. Although such flexible application of intuitive cognitive styles may lead to errors, this strategy is nonetheless adaptive or relatively adaptive in truly adverse environments. However, another possibility is that individuals with experiences of childhood adversity might be unable to provide deliberate responses to the CRT questions because they have engaged in rumination of negative thoughts invoked by the unpleasant environmental cues. This possibility deserves a closer look in future investigations.

Overall, our findings have valuable implications for childcare, education, and relevant interventions. Childhood unpredictability has been demonstrated to undermine individuals' physical and psychological health (Mell et al., 2018; Nusslock & Miller, 2015; Shonkoff & Garner, 2011) as well as cognitive functioning (Brown, 2010; Kim et al., 2019; Pollak et al., 2010). However, past research failed to consider the adaptive trade-offs between functions and costs of intuitive and deliberate cognitive styles. Our findings suggest that a stable and benign childhood environment is conducive to a later proclivity for deliberation, which is at the core of rational thinking (Ayal et al., 2012; Kahneman, 2003). Furthermore, our findings shed light on the crucial adaptive function of intuitive cognitive styles. Intuition is associated with increases in prosocial and cooperative behaviors (Bear & Rand, 2016; Everett et al., 2017; Rand, 2017), which might help individuals endure harsh environmental constraints. The current results revealed that when exposed to danger, individuals with an unpredictable upbringing were more prone to intuitive solutions, which might promote prosocial behaviors, especially in emergency conditions (Shi et al., 2020). Therefore, individuals who grew up in adverse environments do not have an inferior cognitive style but rather a cognitive style that excels in threatening situations. This should also be stressed in education and intervention (Ellis et al., 2020).

The present research has several limitations. First, our two studies relied on retrospective self-report questionnaires to assess participants' childhood unpredictability. Because of the difficulty and unwillingness to recall unpleasant past events, childhood unpredictability may have been underestimated. Future research may adopt a longitudinal approach to more accurately discern the effects of childhood unpredictability on life-history strategies and cognitive styles. Second, previous research reported that individuals' mathematical abilities might affect their performance in the CRT (Campitelli & Gerrans, 2014). However, mathematical skills were not measured or controlled in our study. We attempted to address this concern by using the available data and comparing CRT scores among individuals with different educational levels (assuming that mathematical skills vary with educational levels) and found that participants' CRT performance was not correlated with educational levels, $F(3, 265) = 1.213$, $p = .306$.

## 5. Conclusion

Through two studies, the current research found that individuals who were raised in more unpredictable environments were more likely to exhibit faster life-history strategies, which were associated with a lower preference for deliberate and cautious decision-making. Furthermore, higher childhood unpredictability was predictive of higher reliance on intuitive cognitive style when people were presented with mortality cues but not in situations without mortality cues. Overall, these findings indicate that the intuitive and deliberate cognitive styles serve distinct adaptive functions in both the course of life-history development and situations with evolutionary significance.

## CRediT authorship contribution statement

**Xinrui Wang:** Investigation, Formal analysis, Writing – original draft. **Nan Zhu:** Writing – review & editing. **Lei Chang:** Supervision, Writing – review & editing, Funding acquisition.

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## References

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, white women. *Health Psychology, 19*(6), 586–592. https://doi.org/10.1037/0278-6133.19.6.586.

Amir, D., Jordan, M., & Bribiescas, R. (2016). A longitudinal assessment of associations between adolescent environment, adversity perception, and economic status on fertility and age of menarche. *PLoS One, 11*, Article e0155883. https://doi.org/10.1371/journal.pone.0155883.

Andersson, L., Eriksson, J., Stillesjö, S., Juslin, P., Nyberg, L., & Wirebring, L. (2019). Neurocognitive processes underlying heuristic and normative probability judgments. *Cognition, 196*, Article 104153. https://doi.org/10.1016/j.cognition.2019.104153.

Augusti, E. M., & Melinder, A. (2013). Maltreatment is associated with specific impairments in executive functions: A pilot study. *Journal of Traumatic Stress, 26*(6), 780–783. https://doi.org/10.1002/jts.21860.

Ayal, S., Zakay, D., & Hochman, G. (2012). Deliberative adjustments of intuitive anchors: The case of diversification behavior. *Synthese, 189*, 717–731. https://doi.org/10.1007/s11229-012-0156-1.

Barkley, R. A. (2001). The executive functions and self-regulation: An evolutionary neuropsychological perspective. *Neuropsychology Review, 11*(1), 1–29. https://doi.org/10.1023/A:1009085417776.

Barrett, L. F., Tugade, M. M., & Engle, R. W. (2004). Individual differences in working memory capacity and dual-process theories of the mind. *Psychological Bulletin, 130*(4), 553–573. https://doi.org/10.1037/0033-2909.130.4.553.

Bauer, P. M., Hanson, J. L., Pierson, R. K., Davidson, R. J., & Pollak, S. D. (2009). Cerebellar volume and cognitive functioning in children who experienced early deprivation. *Biological Psychiatry, 66*(12), 1100–1106. https://doi.org/10.1016/j.biopsych.2009.06.014.

Bear, A., & Rand, D. G. (2016). Intuition, deliberation, and the evolution of cooperation. *Proceedings of the National Academy of Sciences of the United States of America, 113*(4), 936–941. https://doi.org/10.1073/pnas.1517780113.

Belsky, J., Schlomer, G. L., & Ellis, B. J. (2012). Beyond cumulative risk: Distinguishing harshness and unpredictability as determinants of parenting and early life history strategy. *Developmental Psychology, 48*(3), 662–673. https://doi.org/10.1037/a0024454.

Belsky, J., Steinberg, L., & Draper, P. (1991). Childhood experience, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Development, 62*, 647–670. https://doi.org/10.1111/j.1467-8624.1991.tb01558.x.

Betsch, C., & Kunz, J. J. (2008). Individual strategy preferences and decisional fit. *Journal of Behavioral Decision Making, 21*(5), 532–555. https://doi.org/10.1002/bdm.600.

Bos, K. J., Fox, N., Zeanah, C. H., & Nelson, C. A. (2009). Effects of early psychosocial deprivation on the development of memory and executive function. *Frontiers in Behavioral Neuroscience, 3*. https://doi.org/10.3389/neuro.08.016.2009.

Brown, M. (2010). Early-life characteristics, psychiatric history, and cognition trajectories in later life. *The Gerontologist, 50*, 646–656. https://doi.org/10.1093/geront/gnq049.

Campitelli, G., & Gerrans, P. (2014). Does the cognitive reflection test measure cognitive reflection? A mathematical modeling approach. *Memory & Cognition, 42*(3), 434–447. https://doi.org/10.3758/s13421-013-0367-9.

Carlson, S. M., Moses, L. J., & Claxton, L. J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*(4), 299–319. https://doi.org/10.1016/j.jecp.2004.01.002.

Carriedo, N., Corral, A., Montoro, P. R., & Herrero, L. (2020). A developmental study of the bat/ball problem of CRT: How to override the bias and its relation to executive functioning. *British Journal of Psychology, 111*(2), 335–356. https://doi.org/10.1111/bjop.12400.

Chang, L., Lu, H. J., Lansford, J., Bornstein, M., Steinberg, L., Chen, B. B., Skinner, A., Dodge, K., Deater-Deckard, K., Bacchini, D., Pastorelli, C., Alampay, L., Tapanya, S., Sorbring, E., Oburu, P., Al-Hassan, S., Giunta, L., Malone, P., Tirado, L., & Yotanyamaneewong, S. (2019). External environment and internal state in relation to life-history behavioural profiles of adolescents in nine countries. *Proceedings of the Royal Society B: Biological Sciences, 286*, Article 20192097. https://doi.org/10.1098/rspb.2019.2097.

Chen, B. B., & Chang, L. (2016). Procrastination as a fast life history strategy. *Evolutionary Psychology, 14*(1). https://doi.org/10.1177/1474704916630314.

Chen, B. B., & Kruger, D. (2017). Future orientation as a mediator between perceived environmental cues in likelihood of future success and procrastination. *Personality and Individual Differences, 108*, 128–132. https://doi.org/10.1016/j.paid.2016.12.017.

Chen, B. B., Shi, Z., & Sun, S. (2017). Life history strategy as a mediator between childhood environmental unpredictability and adulthood personality. *Personality and Individual Differences, 111*, 215–219. https://doi.org/10.1016/j.paid.2017.02.032.

Chua, K. J., Lukaszewski, A., Grant, D., & Sng, O. (2017). Human life history strategies: Calibrated to external or internal cues? *Evolutionary Psychology, 15*, Article 147470491667734. https://doi.org/10.1177/1474704916677342.

Clutterbuck, S., Adams, J., & Nettle, D. (2014). Childhood adversity accelerates intended reproductive timing in adolescent girls without increasing interest in infants. *PLoS One, 9*, Article e85013. https://doi.org/10.1371/journal.pone.0085013.

Cools, E., & Van den Broeck, H. (2007). Development and validation of the cognitive style indicator. *The Journal of Psychology, 141*(4), 359–387. https://doi.org/10.3200/JRLP.141.4.359-388.

Copping, L. T., Campbell, A., & Muncer, S. (2013). Impulsivity, sensation seeking and reproductive behaviour: A life history perspective. *Personality and Individual Differences, 54*(8), 908–912. https://doi.org/10.1016/j.paid.2013.01.003.

Del Giudice, M., & Crespi, B. J. (2018). Basic functional trade-offs in cognition: An integrative framework. *Cognition, 179*, 56–70. https://doi.org/10.1016/j.cognition.2018.06.008.

Dunkel, C. S., van der Linden, D., & Holler, R. H. (2021). Life history strategy and intelligence: Commonality and personality profile differences. *Personality and Individual Differences, 175*, Article 110667. https://doi.org/10.1016/j.paid.2021.110667.

Ellis, B. (2004). Timing of pubertal maturation in girls: An integrated life history approach. *Psychological Bulletin, 130*, 920–958. https://doi.org/10.1037/0033-2909.130.6.920.

Ellis, B., Abrams, L. S., Masten, A. S., Sternberg, R. J., Tottenham, N., & Frankenhuis, W. E. (2020). Hidden talents in harsh environments. *Development and Psychopathology*, 1–19. https://doi.org/10.1017/S0954579420000887.

Ellis, B., & Essex, M. (2007). Family environments, adrenarche, and sexual maturation: A longitudinal test of a life history model. *Child Development, 78*, 1799–1817. https://doi.org/10.1111/j.1467-8624.2007.01092.x.

Ellis, B., Figueredo, A., Brumbach, B., & Schlomer, G. (2009). Fundamental dimensions of environmental risk: The impact of harsh versus unpredictable environments on the evolution and development of life history strategies. *Human Nature, 20*, 204–268. https://doi.org/10.1007/s12110-009-9063-7.

Ellis, B. J., Bianchi, J., Griskevicius, V., & Frankenhuis, W. E. (2017). Beyond risk and protective factors: An adaptation-based approach to resilience. *Perspectives on Psychological Science, 12*(4), 561–587. https://doi.org/10.1177/1745691617693054.

Evans, J. S. B. T., & Curtis-Holmes, J. (2005). Rapid responding increases belief bias: Evidence for the dual-process theory of reasoning. *Thinking & Reasoning, 11*(4), 382–389. https://doi.org/10.1080/13546780542000005.

Evans, J. S. B. T., & Stanovich, K. (2013). Dual-process theories of higher cognition. *Perspectives on Psychological Science, 8*, 223–241. https://doi.org/10.1177/1745691612460685.

Everett, J. A. C., Ingbretsen, Z., Cushman, F., & Cikara, M. (2017). Deliberation erodes cooperative behavior - even towards competitive out-groups, even when using a control condition, and even when eliminating selection bias. *Journal of Experimental Social Psychology, 73*, 76–81. https://doi.org/10.1016/j.jesp.2017.06.014.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/BF03193146.

Figueredo, A. J., Cuthbertson, A. M., Kauffman, I. A., Weil, E., & Gladden, P. R. (2012). The interplay of behavioral dispositions and cognitive abilities: Sociosexual orientation, emotional intelligence, executive functions and life history strategy. *Temas em Psicologia, 20*(1), 87–100. http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1413-389X2012000100008&nrm=iso.

Figueredo, A. J., Garcia, R. A., Menke, J. M., Jacobs, W. J., Gladden, P. R., Bianchi, J., Patch, E. A., Beck, C. J. A., Kavanagh, P. S., Sotomayor-Peterson, M., Jiang, Y. F., & Li, N. P. (2017). The K-SF-42: A new short form of the Arizona life history battery. *Evolutionary Psychology, 15*(1). https://doi.org/10.1177/1474704916676276.

Figueredo, A. J., Vasquez, G., Brumbach, B. H., Schneider, S. M. R., Sefcek, J. A., Tal, I. R., Hill, D., Wenner, C. J., & Jacobs, W. J. (2006). Consilience and life history theory: From genes to brain to reproductive strategy. *Developmental Review, 26*(2), 243–275. https://doi.org/10.1016/j.dr.2006.02.002.

Figueredo, A. J., Vasquez, G., Brumbach, B. H., Sefcek, J. A., Kirsner, B. R., & Jacobs, W. J. (2005). The K-factor: Individual differences in life history strategy. *Personality and Individual Differences, 39*(8), 1349–1360. https://doi.org/10.1016/j.paid.2005.06.009.

Fox, S. E., Levitt, P., & Nelson, C. A. (2010). How the timing and quality of early experiences influence the development of brain architecture. *Child Development, 81*(1), 28–40. https://doi.org/10.1111/j.1467-8624.2009.01380.x.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives, 19*(4), 25–42. https://doi.org/10.1257/089533005775196732.

Gladden, P. R., Welch, J., Figueredo, A. J., & Jacobs, W. J. (2009). Moral intuitions and religiosity as spuriously correlated life history traits. *Journal of Evolutionary Psychology, 7*(2), 167–184. https://doi.org/10.1556/jep.7.2009.2.5.

Griskevicius, V., Ackerman, J. M., Cantu, S. M., Delton, A. W., Robertson, T. E., Simpson, J. A., Thompson, M. E., & Tybur, J. M. (2013). When the economy falters, do people spend or save? Responses to resource scarcity depend on childhood environments. *Psychological Science, 24*(2), 197–205. https://doi.org/10.1177/0956797612451471.

Griskevicius, V., Delton, A. W., Robertson, T. E., & Tybur, J. M. (2011). Environmental contingency in life history strategies: The influence of mortality and socioeconomic status on reproductive timing. *Journal of Personality and Social Psychology, 100*(2), 241–254. https://doi.org/10.1037/a0021082.

Griskevicius, V., Tybur, J., Delton, A., & Robertson, T. (2011). The influence of mortality and socioeconomic status on risk and delayed rewards: A life history theory approach. *Journal of Personality and Social Psychology, 100*, 1015–1026. https://doi.org/10.1037/a0022403.

Hartman, S., Li, Z., Nettle, D., & Belsky, J. (2017). External-environmental and internal-health early life predictors of adolescent development. *Development and Psychopathology, 29*, 1839–1849. https://doi.org/10.1017/S0954579417001432.

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.

Hostinar, C., Stellern, S., Schaefer, C., Carlson, S., & Gunnar, M. (2012). The impact of early life adversity on executive function in children adopted internationally from orphanages. *Proceedings of the National Academy of Sciences of the United States of America, 109*(Suppl. 2), 17208–17212. https://doi.org/10.1073/pnas.1121246109.

Jaekel, J., Eryigit-Madzwamuse, S., & Wolke, D. (2016). Preterm toddlers' inhibitory control abilities predict attention regulation and academic achievement at age 8 years. *The Journal of Pediatrics, 169*, 87–92. https://doi.org/10.1016/j.jpeds.2015.10.029.

Jiménez, N., Rodriguez-Lara, I., Tyran, J.-R., & Wengström, E. (2017). Thinking fast, thinking badly. *Economics Letters, 162*. https://doi.org/10.1016/j.econlet.2017.10.018.

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist, 58*(9), 697–720. https://doi.org/10.1037/0003-066x.58.9.697.

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology, 9*(4), 156–185. https://doi.org/10.1002/1520-6505(2000)9:4<156::Aid-Evan5>3.0.Co;2-7.

Keramati, M., Dezfouli, A., & Piray, P. (2011). Speed/accuracy trade-off between the habitual and the goal-directed processes. *PLoS Computational Biology, 7*(5). https://doi.org/10.1371/journal.pcbi.1002055.

Kim, Y. K., Ham, B. J., & Han, K.-M. (2019). Interactive effects of genetic polymorphisms and childhood adversity on brain morphologic changes in depression. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 41*, 4–13. https://doi.org/10.1016/j.pnpbp.2018.03.009.

Kokis, J. V., MacPherson, R., Toplak, M. E., West, R. F., & Stanovich, K. E. (2002). Heuristic and analytic processing: Age trends and associations with cognitive ability and cognitive styles. *Journal of Experimental Child Psychology, 83*(1), 26–52. https://doi.org/10.1016/S0022-0965(02)00121-2.

Kruger, D. J., Reischl, T., & Zimmerman, M. A. (2008). Time perspective as a mechanism for functional developmental adaptation. *Journal of Social, Evolutionary, and Cultural Psychology, 2*(1), 1–22. https://doi.org/10.1037/h0099336.

Lambert, H. K., King, K. M., Monahan, K. C., & McLaughlin, K. A. (2017). Differential associations of threat and deprivation with emotion regulation and cognitive control in adolescence. *Development and Psychopathology, 29*(3), 929–940. https://doi.org/10.1017/S0954579416000584.

Lovallo, W. R. (2013). Early life adversity reduces stress reactivity and enhances impulsive behavior: Implications for health behaviors. *International Journal of Psychophysiology, 90*(1), 8–16. https://doi.org/10.1016/j.ijpsycho.2012.10.006.

Lu, H. J., & Chang, L. (2019). Aggression and risk-taking as adaptive implementations of fast life history strategy. *Developmental Science, 22*(5), Article e12827. https://doi.org/10.1111/desc.12827.

Maran, T., Ravet-Brown, T., Angerer, M., Furtner, M., & Huber, S. E. (2020). Intelligence predicts choice in decision-making strategies. *Journal of Behavioral and Experimental Economics, 84*, Article 101483. https://doi.org/10.1016/j.socec.2019.101483.

Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology, 16*(3), 429–444. https://doi.org/10.1016/0193-3973(95)90028-4.

Mell, H., Safra, L., Algan, Y., Baumard, N., & Chevallier, C. (2018). Childhood environmental harshness predicts coordinated health and reproductive strategies: A cross-sectional study of a nationally representative sample from France. *Evolution and Human Behavior, 39*(1), 1–8. https://doi.org/10.1016/j.evolhumbehav.2017.08.006.

Merz, E. C., & McCall, R. B. (2011). Parent ratings of executive functioning in children adopted from psychosocially depriving institutions. *Journal of Child Psychology and Psychiatry, 52*(5), 537–546. https://doi.org/10.1111/j.1469-7610.2010.02335.x.

Mishra, S., Templeton, A. J., & Meadows, T. J. S. (2017). Living, fast and slow: Is life history orientation associated with risk-related personality traits, risk attitudes, criminal outcomes, and gambling? *Personality and Individual Differences, 117*, 242–248. https://doi.org/10.1016/j.paid.2017.06.009.

Mittal, C., Griskevicius, V., Simpson, J., Sung, S., & Young, E. (2015). Cognitive adaptations to stressful environments: When childhood adversity enhances adult executive function. *Journal of Personality and Social Psychology, 109*, 604–621. https://doi.org/10.1037/pspi0000028.

Mueller, S., Maheu, F., Dozier, M., Peloso, E., Mandell, D., Leibenluft, E., Pine, D., & Ernst, M. (2010). Early-life stress is associated with impairment in cognitive control in adolescence: An fMRI study. *Neuropsychologia, 48*, 3037–3044. https://doi.org/10.1016/j.neuropsychologia.2010.06.013.

Murray, C., & Greenberg, M. T. (2006). Examining the importance of social relationships and social contexts in the lives of children with high-incidence disabilities. *Journal of Special Education, 39*(4), 220–233. https://doi.org/10.1177/00224669060390040301.

Nunnally, J. C. (1967). *Psychometric theory*. New York: McGraw-Hill.

Nusslock, R., & Miller, G. (2015). Early-life adversity and physical and emotional health across the lifespan: A neuroimmune network hypothesis. *Biological Psychiatry, 80*. https://doi.org/10.1016/j.biopsych.2015.05.017.

Patch, E. A., & Figueredo, A. J. (2017). Childhood stress, life history, psychopathy, and sociosexuality. *Personality and Individual Differences, 115*, 108–113. https://doi.org/10.1016/j.paid.2016.04.023.

Paxton, J. M., & Greene, J. D. (2010). Moral reasoning: Hints and allegations. *Topics in Cognitive Science, 2*(3), 511–527. https://doi.org/10.1111/j.1756-8765.2010.01096.x.

Pollak, S. D., Nelson, C. A., Schlaak, M. F., Roeber, B. J., Wewerka, S. S., Wiik, K. L., Frenn, K. A., Loman, M. M., & Gunnar, M. R. (2010). Neurodevelopmental effects of early deprivation in postinstitutionalized children. *Child Development, 81*(1), 224–236. https://doi.org/10.1111/j.1467-8624.2009.01391.x.

Promislow, D., & Harvey, P. (1990). Living fast and dying young: A comparative analysis of life-history variation among mammals. *Journal of Zoology, 220*, 417–437. https://doi.org/10.1111/j.1469-7998.1990.tb04316.x.

Quinlan, R. J. (2003). Father absence, parental care, and female reproductive development. *Evolution and Human Behavior, 24*(6), 376–390. https://doi.org/10.1016/S1090-5138(03)00039-4.

Rand, D. G. (2017). Social dilemma cooperation (unlike dictator game giving) is intuitive for men as well as women. *Journal of Experimental Social Psychology, 73*, 164–168. https://doi.org/10.1016/j.jesp.2017.06.013.

Richardson, G. B., & Hardesty, P. (2012). Immediate survival focus: Synthesizing life history theory and dual process models to explain substance use. *Evolutionary Psychology, 10*(4), 731–749. https://doi.org/10.1177/147470491201000408.

Rickard, I., Frankenhuis, W., & Nettle, D. (2014). Why are childhood family factors associated with timing of maturation? A role for internal prediction. *Perspectives on Psychological Science, 9*, 3–15. https://doi.org/10.1177/1745691613513467.

Rushton, J. P. (2004). Placing intelligence into an evolutionary framework or how *g* fits into the *r–k* matrix of life-history traits including longevity. *Intelligence, 32*(4), 321–328. https://doi.org/10.1016/j.intell.2004.06.003.

Sheridan, M. A., Peverill, M., Finn, A. S., & McLaughlin, K. A. (2017). Dimensions of childhood adversity have distinct associations with neural systems underlying executive functioning. *Development and Psychopathology, 29*(5), 1777–1794. https://doi.org/10.1017/S0954579417001390.

Shi, R., Qi, W., Ding, Y., Liu, C., & Shen, W. B. (2020). Under what circumstances is helping an impulse? Emergency and prosocial traits affect intuitive prosocial behavior. *Personality and Individual Differences, 159*. https://doi.org/10.1016/j.paid.2020.109828.

Shiloh, S., Salton, E., & Sharabi, D. (2002). Individual differences in rational and intuitive thinking styles as predictors of heuristic responses and framing effects. *Personality and Individual Differences, 32*(3), 415–429. https://doi.org/10.1016/S0191-8869(01)00034-4.

Shonkoff, J., & Garner, A. (2011). The lifelong effects of early childhood adversity and toxic stress. *Pediatrics, 129*, e232–e246. https://doi.org/10.1542/peds.2011-2663.

Sih, A., & Del Giudice, M. (2012). Linking behavioural syndromes and cognition: A behavioural ecology perspective. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 367*, 2762–2772. https://doi.org/10.1098/rstb.2012.0216.

Simpson, J., Griskevicius, V., Kuo, S., Sung, S., & Collins, W. (2012). Evolution, stress, and sensitive periods: The influence of unpredictability in early versus late childhood on sex and risky behavior. *Developmental Psychology, 48*, 674–686. https://doi.org/10.1037/a0027293.

Stearns, S. C. (1989). Trade-offs in life-history evolution. *Functional Ecology, 3*(3), 259–268. https://doi.org/10.2307/2389364.

Teicher, M. H., Samson, J. A., Anderson, C. M., & Ohashi, K. (2016). The effects of childhood maltreatment on brain structure, function and connectivity. *Nature Reviews Neuroscience, 17*(10), 652–666. https://doi.org/10.1038/nrn.2016.111.

Tiego, J., Testa, R., Bellgrove, M. A., Pantelis, C., & Whittle, S. (2018). A hierarchical model of inhibitory control. *Frontiers in Psychology, 9*(1339). https://doi.org/10.3389/fpsyg.2018.01339.

Vaske, J. J., Beaman, J., & Sponarski, C. C. (2017). Rethinking internal consistency in Cronbach's alpha. *Leisure Sciences, 39*(2), 163–173. https://doi.org/10.1080/01490400.2016.1127189.

Waller, B. N. (1999). Deep thinkers, cognitive misers, and moral responsibility. *Analysis, 59*(4), 223–229.

Warren, S., & Barnett, M. (2020). Effortful control development in the face of harshness and unpredictability. *Human Nature*, 1–20. https://doi.org/10.1007/s12110-019-09360-6.

Wenner, C. J., Bianchi, J., Figueredo, A. J., Rushton, J. P., & Jacobs, W. J. (2013). Life history theory and social deviance: The mediating role of executive function. *Intelligence, 41*(2), 102–113. https://doi.org/10.1016/j.intell.2012.11.004.

Woodley, M. A. (2011). The cognitive differentiation-integration effort hypothesis: A synthesis between the fitness indicator and life history models of human intelligence. *Review of General Psychology, 15*(3), 228–245. https://doi.org/10.1037/a0024348.

Woodley of Menie, M., Luoto, S., Peñaherrera-Aguirre, M., & Sarraf, M. (2021). *Life history is a major source of adaptive individual and species differences: A critical commentary on Zietsch and Sidari (2020)* (pp. 1–19). Evolutionary Psychological Science. https://doi.org/10.1007/s40806-021-00280-2.

Young, E. S., Griskevicius, V., Simpson, J. A., Waters, T. E. A., & Mittal, C. (2018). Can an unpredictable childhood environment enhance working memory? Testing the sensitized-specialization hypothesis. *Journal of Personality and Social Psychology, 114*(6), 891–908. https://doi.org/10.1037/pspi0000124.

Zhu, N., Hawk, S. T., & Chang, L. (2018). Living slow and being moral. *Human Nature, 29*(2), 186–209. https://doi.org/10.1007/s12110-018-9313-7.