



Review

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The evolved psychological mechanisms of fertility motivation: hunting for causation in a sea of correlation

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Cultural, ecological, familial and physiological factors consistently influence fertility behaviours, however, the proximate psychological mechanisms underlying fertility decisions in humans are poorly understood. Understanding the psychological mechanisms underlying human fertility may illuminate the final processes by which some of these known predictors have their influence. To date, research into the psychological mechanisms underlying fertility has been fragmented. Aspects of reproductive psychology have been examined by researchers in a range of fields, but the findings have not been systematically integrated in one review. We provide such a review, examining current theories and research on psychological mechanisms of fertility. We examine the methods and populations used in the research, as well as the disciplines and theoretical perspectives from which the work has come. Much of the work that has been done to date is methodologically limited to examining correlations between ecological, social and economic factors and fertility. We propose, and support with examples, the use of experimental methods to differentiate causal factors from correlates. We also discuss weaknesses in the experimental research, including limited work with non-WEIRD (western, educated, industrialized, rich and democratic) populations.

1. Introduction

This paper reviews the literature on psychological mechanisms underlying human fertility. We focus on research using experimental methods, as these can extend our understanding beyond correlation and towards causation. Research from a range of theoretical backgrounds and academic disciplines is considered. After our literature search methodology, we discuss the main theoretical standpoints of the studies and the methods used, before summarizing the work across 16 categories of proposed causative factors. Many of these categories are inter-related, highlighting the complexity of human fertility. Here we partition them for the sake of brevity and parsimony. We end with a critique of experimental methods and a call for more work in this area.

2. Methodology

L.M. and S.V. conducted the literature searches using Google Scholar; PsychInfo, PubMed and Web of Science search engines in June 2014. Searches were conducted using one primary search term—'psychological mechanism' or 'psychological pathway'—and one secondary search term. The secondary search terms were age at first birth, baby fever, childbearing, childlessness, contraceptive use, cooperative breeding, family planning, father absence, fertility, fertility desires, fertility intentions, fertility motivation, fertility preferences, ideal family size, parental investment, parenthood,

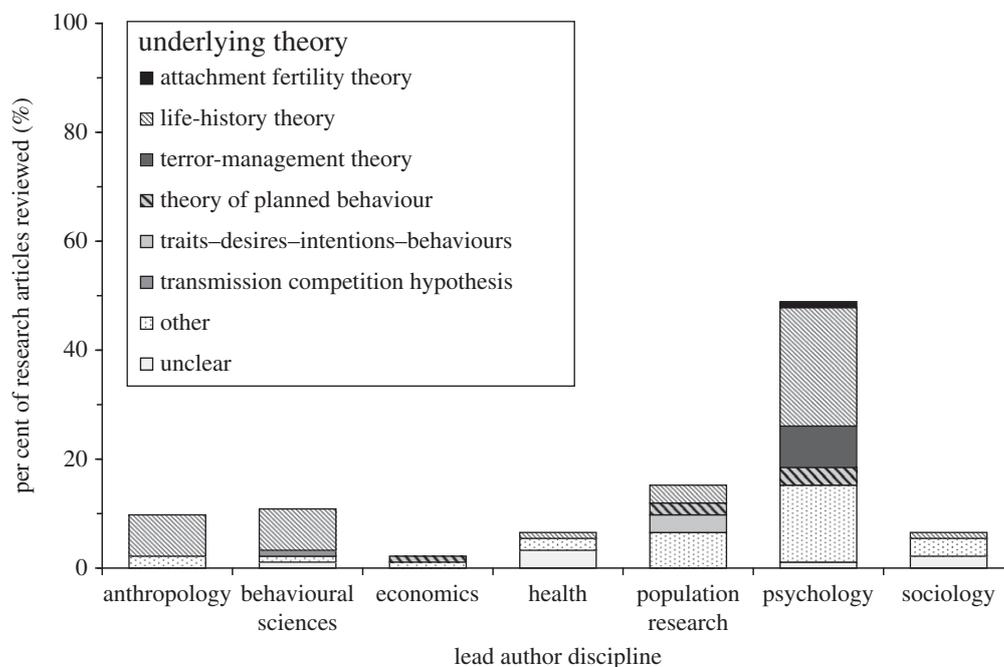


Figure 1. Percentage of research papers reviewed here by lead author's discipline and the underlying theory of the paper ($N = 92$ papers). Population research refers to authors from demography, population studies and population research departments or institutes. Health refers to authors from medical, public health and family health departments.

parenting, reproduction, reproductive autonomy, reproductive decision-making, reproductive timing, sex ratios, sexual coercion and value of children. All connotations of these terms and tenses were tried.

This initial search resulted in over 40 000 articles, including duplicates across the four databases. Consequently, for each search only the first three pages of results were evaluated against our inclusion criteria based on title and abstract. To be included studies had to: (i) be written in English; (ii) include quantitative analyses; (iii) examine at least one secondary search term; and (iv) address the underlying psychology influencing human fertility.

To ensure that our review included all apposite articles, key articles were searched for references, and Google Scholar citation searches run on them. The article list was updated in August 2015 by all authors. This process resulted in 247 articles.

L.M. and S.V. skimmed the main body of the articles to ensure they met the inclusion criteria. This process eliminated 155 articles, resulting in 92 reviewed research articles. The additional 49 articles referenced herein are referenced to explain theories, methods and underlying principles. For the 92 research articles, we compiled a list of articles and extracted data on lead author discipline, underlying theory, study design (non-experimental or experimental), study population, and the dependent and independent variables used (see the electronic supplementary material).

For 49% of the research articles, the lead author was from a psychology department (figure 1). Life-history theory (see §3b) was the most common underlying theory—42% of the research articles. Only 27% of the research articles used experimental methods (discussed in §4b), 67% of which used university students (figure 2). Study populations were predominantly taken from the general public (56%), and from high income countries (79%), with the USA (35% of articles) and UK (15% of articles) being heavily represented. Few research articles had study populations of multiple types (15%; e.g. university students and the general public) or study populations from multiple countries (10%). Subjects ranged in age from 9 to 75+ years. Most research articles had both male and female participants (64%); however, 33% of articles had solely female subjects and 3% solely male subjects.

3. Theories

The research reviewed here comes predominantly from six theoretical standpoints: *attachment fertility theory* [1,2], *life-history theory* [3,4], *terror-management theory* [5,6], *theory of planned behaviour* [7,8], *transmission competition hypothesis* [9,10] and the *traits-desires-intentions-behaviours* model [11]. The percentage of papers using each of these theories is shown in figure 1 by lead author discipline. Note, beyond the scope of this paper, numerous other theoretical frameworks have been applied to fertility motivation and behaviours including the kin influence hypothesis [12], famine syndrome [13], replacement/insurance theory [14,15], purposive action [16] and theory of commitment [17].

(a) Attachment fertility theory

Attachment fertility theory proposes that close enduring relationships are an evolved adaptation to offspring that require substantial parental care from multiple carers [1,2]. Close enduring relationships help to ensure that offspring from a union are sufficiently provided for. Work using this theory is discussed in §6k.

(b) Life-history theory

Life-history theory suggests that given finite time, limited budgets, and the basic tenet that resources used for one purpose cannot be used for another, individuals must make trade-offs among investment in their own growth and maintenance, their current reproduction and any future reproduction [3,4]. Trade-offs vary as a function of individual characteristics (e.g. genetic quality and embodied capital) and as a function of environmental conditions (e.g. harshness, unpredictability and resource scarcity) [18]. For example, higher local mortality risk is associated with earlier reproduction. This is thought to offset the risk of death before reproducing, and to increase

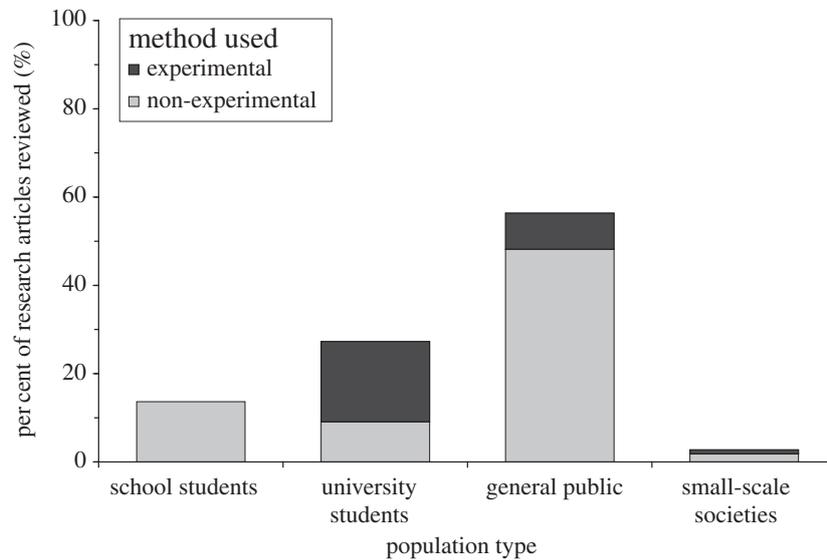


Figure 2. Percentage of research papers reviewed here by the population type of research participants, and the method used ($N = 92$ papers). School students were aged 9–18 years, university students were usually between 18 and 25 years old and the general public ranged in age from 16 to 75+ years. Fourteen papers reviewed here had mixed populations of school students and university students, school students and the general public, or university students and the general public. Consequently, these 14 papers are represented twice in the figure, once in each population type from which the mixed sample came.

the likelihood that children can be raised to an age at which they can reproduce themselves [4,19–22].

The ways in which an individual manages the trade-offs that allocate energy and dictate the timing of development constitutes their life-history strategy. Slow life-history strategies are characterized by greater somatic investment, delayed sexual development and reproduction, lower fertility and heavy investment in each offspring. Fast life histories are characterized by less somatic investment, accelerated sexual development and reproduction, higher fertility and lower investment in each offspring. Ancestral environments determine the species-specific position on the life-history continuum. Prenatal, childhood, immediate and predicted environments then fine-tune an individual's position on the continuum relative to peers [23]. In other words, life-history strategies are facultative—determined by our childhood environments toward relatively fast or slow trajectories, but likely to remain pliable in the face of new information. Numerous papers reviewed here were theoretically grounded in life-history theory (see especially §§5a–f, 6a–e,g,o,p).

(c) Terror-management theory

Terror-management theory proposes that humans face a unique psychological conflict: we desire to live but realize the inevitability of death, which induces terror that we alleviate by ensuring immortality through cultural (e.g. belief in an afterlife) and biological (e.g. reproducing) means [5,6]. Work using this theory is discussed in §6p.

(d) Theory of planned behaviour

The theory of planned behaviour has a four-step pathway (see fig. 1 in [8]): (i) people have beliefs about the outcomes of specific behaviours, how others feel about that behaviour and whether certain factors affecting the behaviour are present [7,8,24]; (ii) these beliefs shape people's attitudes and subjective norms about a behaviour, and perceived degree of control over the behaviour; (iii) attitudes, subjective norms and perceived

control shape the intention to perform the behaviour, which is modified by people's actual control over the behaviour; and (iv) the pathway ends with the behaviour.

The theory of planned behaviour has been applied to contraceptive use, but rarely to other fertility-related behaviours. In 2009, the theory of planned behaviour was the grounding of a REPRO project, where it was used to address how the surrounding macro environment (government policies, economic crises, etc.) affects individual-level reproductive decision-making [24]. An advantage of this theory is that it does not assume people are rational [25]. Research from a theory of planned behaviour perspective is discussed in §6d,i,m,n.

(e) Transmission competition hypothesis

The transmission competition hypothesis was developed to better understand below-replacement fertility rates in high-income countries [9,10]. It suggests we have a legacy drive—a desire for immortality and to leave something of oneself for the future. Originally this was achieved through genetic transmission; however, a by-product is a drive to invest in any activity that provides a lasting legacy, such that in high income countries meme transmission—e.g. career development and wealth accumulation—can placate this drive (see fig. 2 in [9]). Research grounded in the transmission competition hypothesis is discussed in §6l,n.

(f) Traits—desires—intentions—behaviours

The traits—desires—intentions—behaviours framework outlines the sequence of motivational dispositions and conscious states that lead humans to behave so as to have or avoid having children (see fig. 1 in [26]). The framework starts with positive and negative childbearing motivational traits that lead to desires for or against having children. These desires lead to corresponding fertility intentions. These intentions lead to behaviours orientated towards the achievement or avoidance of pregnancy. Fertility desires and intentions are considered

distinct factors that are expected to change over the life-course due to changes in external, social and economic constraints, and internal maturational factors, including decisions that compete with childbearing [11,26]. Fertility decisions are made one birth at a time, with each birth feeding back upon the system. Major life events in other behavioural domains (e.g. education, career and partner relations) also feed back into the system. The traits–desires–intentions–behaviours framework is comparable with the *theory of planned behaviour*, but traits–desires–intentions–behaviours was developed specifically to address human fertility. Research grounded in this theory is discussed in §§5c,d, and 6a,d,m.

4. Research methods

The methods used in the reviewed research articles fall into two main categories: (i) non-experimental studies (correlative cross-sectional or longitudinal studies); and (ii) experimental studies (priming or vignette methodologies). Figure 2 shows the percentage of research papers ($N = 92$) reviewed by population and method type.

(a) Non-experimental studies

Most of the research to date has used correlational survey data (see [25,27–30] for a review of correlational studies on human fertility broadly construed). These studies are useful in highlighting factors that may influence the underlying psychological mechanisms of human fertility; however, they can only hint at causal relationships. Some natural experiments have used disasters and economic crises to make more externally valid comparisons between affected and unaffected populations [13–15,31]. However, in natural experiments, multiple environmental factors tend to change simultaneously (e.g. mortality, morbidity, resource scarcity and distribution of kin), making it difficult to isolate causal relationships, or describe the underlying psychological mechanisms. Experimental methods are better suited to this task.

(b) Experimental studies

Experimental methods are used to isolate causal factors by running an experiment many times with only one variant. If the results change with the variant then that variant is likely the cause. There is an increasing call for the use of experimental methods in studying human behaviour [32–34]. However, there are challenges in using experimental methods given the complexity and difficulty of conducting experiments in field settings, where it is harder to control conditions. The adequacy of experimental design in settings with irregular and non-predictable variation (i.e. naturalistic settings with humans) has been examined and is increasingly supported by new statistical theories and methods [33].

Ongoing resistance to experimental methods is due to beliefs that experiments—especially laboratory based experiments—lack realism, generalizability and replicability compared with traditional methods, such as demographic surveys and naturalistic observations [32–34]. However, concerns regarding low realism in experimental methods—particularly in laboratory-based experiments—may be outweighed by the benefits of being able to isolate causal effects, and control variation, allowing for the manipulation of environments in a way that is hard to duplicate in naturalistic settings [32].

Experimental methods can also provide high internal validity [33]; however, they have potentially low external validity compared with traditional field methods. Taking experimental methods into field settings, as many behavioural economists do [35], can be useful. It can provide high external validity, providing cultural and educational differences are addressed; reduce critiques regarding realism; and increase the generalizability of findings. For example, field experiments with factorial designs with vignettes embedded alongside standard survey instruments have proven successful [36].

To date, most research using experimental methods has used university populations in which the WEIRD (western, educated, industrialized, rich and democratic) are over-represented and many participants have limited experience with the behaviours of interest [37] (figure 2). However, using university populations may be considered valid when piloting new methods, examining assumed human universals, or predictions are independent of assumptions concerning the subject pool. Increasingly, experimental methods are being used with non-university populations [38–41], populations with specific and relevant experience [42,43], and with populations in developing countries [12,36]. These studies extend the application of experimental methods and have been somewhat successful in addressing the causal pathways that underlie human fertility. However, experiments tend to be hindered by having smaller sample sizes than typical surveys, making generalizations difficult due to the lack of formal weighting systems.

The experimental methods found in the literature reviewed here consist mainly of factorial designs (see [33,44] for overviews of factorial experimental design, including its pros and cons). These studies used priming methods, or presented participants with hypothetical vignettes and asked participants what they would do under the circumstances described. Vignette experiments probably access conscious decision-making, as participants must state a clear opinion on the vignette [12,36]. Priming experiments examine unconscious decision-making processes [45,46].

(i) Vignettes

A vignette is a short, crafted, scenario about a person, object or situation, used to elicit people's beliefs, attitudes, judgements, knowledge or intended behaviour with respect to the presented scenario. Factorial design allows for the estimation of the effects of multiple factors and their interactions. When combined, vignettes and factorial designs can be used to present participants with combinations of hypothetical situations and personal characteristics that are rarely available for study in natural populations. This allows researchers to understand what participants would do, or expect others to do, in given situations. The use of vignettes is common in anthropological studies with small-scale societies [36]. Vignette studies are also well suited to testing hypotheses cross-culturally and have been shown to be predictive of actual behaviour (suggesting ecological validity). However, vignette studies can only assess what a participant thinks a hypothetical person should do, not what the participant would actually do in that situation.

In the literature reviewed here, vignettes were embedded in traditional surveys, used in online/computer-based surveys, and in-person interviews with university populations [47–49], the general public in developed and developing countries [12],

and with traditional populations [36]. These researchers used vignettes to address influences on maternal care [36], fertility aspirations [47], contraceptive use [48], sexual coercion [49], preference for long- versus short-term mating opportunities [50,51] and tendency toward aggressive or generative behaviour [52]. See §§5a–e, 6b,h,i,l–p.

(ii) Priming

Priming is used to elicit an implicit memory effect whereby exposure to one stimulus influences how participants react to another stimulus, usually unbeknownst to the participant. Participants are randomly assigned to different conditions, at least one of which is a priming condition and one a control condition. After priming, participants' responses are measured, and the responses of participants in the primed versus control conditions are compared.

In the literature reviewed here, primes were embedded within traditional surveys, used in online/computer-based surveys, and in-person interviews with university populations [43,45,46,53–56], and with the general public in developed and developing countries [6,38–43,57–60]. We found no examples of primes being used in traditional societies to study reproductive behaviour. We found that priming was used to investigate influences on sexual and non-sexual risk taking [43,53,54], mate choice [39,40,46,56], fertility intentions and interest in children [6,38,41,45,57–60], and parental investment preferences [39,42,55]. Participants were primed through a variety of means, including: reading texts [40,45,46,54,56], word completion tasks ([6,41], photos [43,46], thought experiments [42,57,59,60], memory essays [53,55] and preceding questions [38,39,58] (see §§5a,c–e, 6b,c,e,j–l,o,p).

5. Measuring reproductive decision-making

The factors explored for their associations with human fertility vary wildly, and affect, to some degree, the type of methods used. The factors are discussed below. First, we discuss the measures of human reproductive decision-making and fertility on which researchers have hitherto focused. We discuss the dependent measures first, to help clarify later sections of this paper. Table 1 shows the dependent and independent variables used in the research papers reviewed here by the paper's theoretical grounding. Mating choices and sexual coercion are not reproductive outcomes *per se*, but are considered here because they have direct effects on reproductive outcomes.

(a) Mating preferences and choice

Numerous researchers have investigated factors predicted to influence preferences for short- versus long-term mating opportunities, and preferred mate characteristics (e.g. wealth, attractiveness, size). For example, to examine how local ecology influences preferences for relationship length and partner type, Little *et al.* [40] used vignettes to suggest the local ecology was harsh or safe, and Cohen & Belsky [51] used vignettes to suggest the local environment was predictable and safe, predictable but risky, or unpredictable and fluctuating between safe and risky. Hill *et al.* [56] examined preferences for female body size in harsh versus non-harsh environments using priming. Dunkel *et al.* [50] used vignettes suggesting participants had five months, 5 years or 50 years left to live, to

explore how life expectancy affects preferences for short- or long-term mating (see §6b,o,p).

Chipman & Morrison [61] discuss the importance of the operational sex ratio: male-biased populations favour female mate choice and female-biased populations favour male mate choice, affecting union formation, stability and reproduction. Lainiala & Miettinen [62] discuss how secondary sex ratio affects union formation and fertility across different regions of Finland (see §6g,i).

(b) Sexual coercion

In the studies we reviewed, sexual coercion was measured in terms of willingness to manipulate or force a partner to perform a sexual act. For example, Dunkel & Mathes [49] used vignettes to explore how mortality risk affects willingness to sexually coerce another, and how preferences for short- versus long-term mating interact with this. Dunkel & Mathes [63] continued their research into sexual coercion with non-experimental methods. They explored the relationship between sexual victimhood (being a victim of sexual coercion, often in childhood) and later perpetration of sexual coercion in both sexes. Woolf & Maisto [48] explored how inequality within relationships affects the low-power partner's ability to initiate contraceptive use, which may be indicative of potential for victimhood (see §§5c, 6b,i,p).

(c) Sexual risk taking and contraceptive use

Studies on contraceptive use largely focus on what motivates effective contraceptive use versus either ineffective and/or inconsistent use or non-use. Sexual risk taking studies focus on number of partners and propensities towards having unprotected sex or sex outside a committed relationship.

Miller [64] explored what affects consistency of women's contraceptive use, including whether a woman was motivated to not reproduce, whether the contraceptive method required an explicit decision at use (e.g. condoms), perceived risks of contraceptive use and partner support of contraceptive use. Miller [64] also explored how women's use of contraceptives fluctuates as their motivation to remain childless changes with their economic, relationship, social, and cultural status. Woolf & Maisto [48], using experimental methods, explored how power within a relationship influences men's and women's ability to initiate contraceptive use. Miller *et al.* [2] explored how emotional closeness to partner in homosexual men affects sexual risk taking (see §§5b, 6d,i,k,m).

From a *life-history theory* perspective, Chipman & Morrison [65] investigated whether adolescent sexual risk taking and pregnancy is due to: (i) perceptions of high mortality risk in the environment; (ii) good access to alloparents or cooperative breeding networks; (iii) poor knowledge of safe sexual practices; or (iv) structural risk in the environment (see [66–69] for in-depth discussions of factors influencing adolescent sexual risk taking). DelPriore & Hill [53], using experimental methods, explored how father absence/disengagement affects undergraduate women's sexual permissiveness and risk taking (see §6c,k,p).

(d) Wanting and not wanting children

(i) Interest in infants

Several studies propose that interest in infants may encourage reproduction and motivate the acquisition of childrearing

Table 1. The dependent and independent variables of the research papers reviewed here by underlying theory of the paper ($N = 92$ papers).

variable	theory										total papers using that variable
	attachment fertility theory	life-history theory	terror-management theory	theory of planned behaviour	transmission competition hypothesis	traits – desires – intentions – behaviours	other	unclear			
<i>dependent variables used</i>											
mate preferences and choice		7					2				9
sexual coercion		2									2
sexual risk taking and contraceptive use	1	4		1		1	3				10
wanting and not wanting children		14	5	4	1	2	8	6			40
parental investment		6	1				7	1			15
reproductive outcomes		15	1	1			12	1			30
<i>independent variables used</i>											
heritability of a need to nurture		2				1					3
childhood stress		13		1							14
father absence		4									4
personality		1		2		1	6	1			11
attachment style			2				3				5
sex ratio of mating pool		4									4
relationship with partner				2		1	4	4			11
reproductive autonomy		6		1			2	1			10
paternity and maternity uncertainty		1					3				4
cooperative breeding and kin support	1	3					3	1			8
cost of children		5		4	1		4	4			18
cultural norms		2		4		2	2				10
religiosity				3	1		4				8
resource stress and limitation		10		3			4	3			20
mortality risk and salience		18	7				3				28

skills that help ensure the survival of children [21,55,70]. For example, Maestripieri *et al.* [70] and Clutterbuck *et al.* [21] explored how father absence and childhood adversity, respectively, affect interest in infants among adolescent girls. Clutterbuck *et al.* [21] also explored the relationship between interest in infants and preferred age at first birth. Hill & DelPriore [55] investigated how jealousy, especially chronic jealousy, affects male and female university students' interest in infants (see §6b,c,j,k).

(ii) Childbearing motivation

Many attempts have been made to construct scales measuring childbearing motivation—favourable or unfavourable dispositions toward childbearing. For example, in Portugal, Guedes *et al.* [71] investigated positive and negative motivational factors such as personal fulfilment, childrearing burden, immaturity, financial problems and economic constraints (see §6a,l,n,p).

(iii) Baby fever

The research has also included attempts to anatomize 'baby fever', the visceral physical and emotional desire to have a baby. Rotkirch [72] investigated baby fever in Finnish women using interviews and found that triggers included age, falling in love, previous pregnancies and exposure to babies of kin and peers. It can manifest as a care-oriented personality; and sometimes as a surprising physical longing described as being similar to other biological drives. Brase & Brase [73] created the attitudes towards babies scale, which operationalizes aspects of baby fever, to explore differences in baby fever by sex, exposure to infants and perceived trade-offs between reproduction and education or career (see §6a,h,l).

(iv) Fertility desires and intentions

There is a large demographic literature on fertility desires and intentions. This is usually measured in terms of acceptance of a first or new pregnancy, preferred family size and/or age at first birth. For example, McQuillan *et al.* [74] explored how preferred completed family size, attitudes toward motherhood, age, parity, ethnicity, and self-perceived fecundity related to acceptance of a new pregnancy amongst women in the USA. Griskevicius *et al.* [45] explored how high mortality risk influences preferred age at first birth using experimental methods (see §6h,l,m,p).

(v) Childlessness and postponement of reproduction

A number of studies have explored the desire to delay age at first birth or to not have children at all. Research investigating fertility postponement and childlessness in high-income countries finds that people adjust their fertility desires to situational factors and adjust their desires if they are unlikely to be met [75]. In a Swedish study, Schytt *et al.* [76] explored how age influenced intention to become a parent among childless adults. They also investigated the interaction between age and other factors known to associate with reproductive intentions, such as concerns about fecundity, finding a suitable partner, independence, career trade-offs and economic limitations (see §6l,n).

(e) Parental investment decisions and preferences

In studies of parental investment, the outcome variables used include maternal and paternal investment of time and economic resources, and the provision of healthcare. Kushnick [36] used a third-party vignette experiment to investigate the role of five factors—mother's age and access to resources, and child's age, gender and viability—in shaping decisions related to maternal care among Indonesian Karo Batak agriculturalists. Hill & DelPriore [55] cued jealousy in participants to explore its effect on parental investment preferences. The parental investment literature also considers how the parental investment a participant received affects their behaviour in adolescence and adulthood (§6b,c). *Mating preferences and choice* (§5a) and *attachment style* (§6e) also have literature that considers partner's potential parental investment.

(f) Reproductive outcomes

For 33% of the non-experimental research papers reviewed here, actual age at first birth, fertility to date, or parental investment from the parent's or child's perspectives are outcome variables. For example, short life expectancy is associated with earlier age at first birth [68,77,78], higher fertility [77,79] and lower parental investment in each child [80]. See §3b for a discussion of this.

6. What influences human reproductive psychology?

In this section, we discuss the independent variables researchers have explored in regard to psychological mechanisms influencing human fertility. Discussing the interlinked nature of the causative factors and reproductive outcomes in depth is beyond the scope of this paper. Instead, we highlight research to date and suggest articles readers can explore for discussions of the complex inter-related influences upon human reproduction.

(a) Heritability of a need to nurture

Miller [26] suggests a possible heritable genetic component to positive attitudes towards childbearing and high fertility. Among siblings and cousins, Miller [26] found a heritability component of 70% for fertility desires and 40% for fertility intentions. Although, this could be due to cultural as well as genetic transmission. Miller [26] found three genetic polymorphisms associated with personality traits strongly associated with fertility motivations, desires and intentions. Nurturance personality traits were directly associated with positive childbearing motivation and childbearing desires, and indirectly associated with child-number desires and childbearing intentions (see fig. 1 in [26]). This work is grounded in the *traits–desires–intentions–behaviour* framework (§3f).

Basten [81] also debates whether a need to nurture is biologically programmed and suggests that human children need to be nurtured to become successful adults, and adults need to nurture to grow up and accomplish a full life cycle of experiences. The need to nurture is strongest in women and varies throughout the life course. It may have partially evolved through mate selection: nurturing behaviour advertises parenting quality to potential mates.

The strength of the need to nurture is probably under hormonal control and affected by building a committed relationship, household formation and ageing. Basten [81] suggest a need to nurture is initially triggered in childhood, by nurturing cues such as caring for younger siblings, and increased by exposure to children in adulthood. Adair [28] also found that more frequent exposure to children in adulthood increased fertility desires and positive attitudes towards babies. Therefore, as kin networks decline and family size shrinks, the nurturing instinct is less likely to be triggered.

Rotkirch [72] found exposure to children encouraged baby fever in women. However, Basten [81] and Rotkirch [72] (see §5d) note that baby fever is separate from a nurturing personality, and affects both women who always wanted children and women who previously did not. Baby fever also occurs in men [82]. However, it may be more likely to occur when men are trying to have a child, thus prolonging their proceptive behaviour.

Chasiotis *et al.* [83] found that the presence of younger siblings increased fertility intentions in older siblings, and lowered their preferred age at first birth across three culturally distinct populations. They suggest that caring for younger siblings has pronatal effects that may explain correlations in family size between generations, and why fertility decline takes at least a generation to occur. They also suggest that fertility is not heritable—rather, exposure to younger siblings triggers pronatal tendencies and consequently higher fertility (see §6k).

(b) Childhood stress

Clutterbuck *et al.* [21] studied *interest in infants* (§5d) as a putative mechanism linking childhood adversity and reproductive timing among English girls aged 9–14 years. They found that participants who experienced greater childhood adversity reported an earlier ideal age at parenthood, while participants who faced less childhood adversity were more interested in infants. The authors speculate that interest in infants may not indicate earlier intended age at first birth but rather a future quality-led parental investment strategy, as in the attachment literature (§6e). As Belsky [84] summarizes, lower childhood adversity may bias individuals towards a slower, quality-led, reproductive strategy. Several papers examine, from a *life-history theory* perspective, how childhood experiences influence participants' responses to experimental cues of environmental harshness in adulthood [45,46,49,50, 52,54–56,63] (see §6o,p).

(c) Father absence

This literature suggests that father absence encourages women in particular to gravitate towards earlier sexual maturity, greater sexual risk taking and earlier first birth [21,53,70,80,84]. DelPriore & Hill [53] primed paternal absence or disengagement by making women think about an important time in their life when their father was unavailable. Cues of paternal disengagement were associated with women thinking more sexualized thoughts; and, increased self-reported sexual permissiveness and negativity towards condom use—all indirectly related to fertility outcomes. Maestripieri *et al.* [70] surveyed 11- to 14-year-old girls and found that father absence was strongly and independently correlated with both early menarche and preferences for pictures and silhouettes of infants, adjusting for age and previous experience with infants.

However, Clutterbuck *et al.* [21] used similar measures with 9- to 14-year-old girls and found that those with less childhood adversity (including father absence) were more interested in infants, contrary to predictions.

(d) Personality

Different personality dimensions, appear to be differentially correlated with fertility [85,86]. Personality is commonly measured using the five-factor model. Its dimensions are extraversion, openness, conscientiousness, agreeableness and neuroticism [87]. These five factors have been observed cross-culturally [88–90] and are highly heritable, genetically polymorphic and normally distributed [91]. Individual variation in personality may represent different adaptive strategies with the same reproductive and survival-related goals.

Extraversion (typified by activity, sociability and dominance) positively predicts fertility [92], lifetime number of sexual partners and propensity for leaving a relationship [93] and, in Senegalese males, it also predicted polygyny [86]. Conscientiousness seems to decrease fertility, for example, in Norwegian women across 40 years of data [92] and in British panel data [94] conscientious women postponed childbearing. In Finnish data, the association increased in later cohorts and in both sexes [95]. Openness to experience (intellect; creativity) was negatively related to fertility in British women, partly because it positively predicted educational uptake and fertility postponement [94]. This has been echoed in males [94] and increasingly in younger birth cohorts for both sexes [95], though inconsistently [96]. Agreeableness (cooperativeness; empathy) predicts higher fertility at least in females [95], also including reproductive acceleration [94].

Neuroticism has the most complex relationship to fertility. It may predict more short-term mating [97] or accelerate childbirth [94], yet has been found to depress fertility altogether [96]. In Senegal [86], neurotic women had more children but, if they were low status, they had poorer quality offspring, perhaps indicating a trade-off. Personality likely acts on fertility via a number of routes, including: aiding mate retention [98]; likelihood of consistent contraceptive use [64]; and influencing subjective norms and perceived behavioural control [8]. Personality is discussed further in §§3d–f, 5d and 6a.

(e) Attachment style

Studies on attachment style propose that how infants are treated by carers results in lasting personal styles of relationship formation in adulthood. This idea originated with Bowlby [99], who claimed that the child's attachment to the mother is adaptive as it enhances the likelihood of survival. Researchers have continued the evolutionary theorizing and suggest that those who were insecurely attached as children tend to have earlier sexual maturation and debut, shorter-term and less-stable pair bonds, and invest less in each child but have more of them—tendencies that are thought to be adaptive in a harsh or unpredictable environment (e.g. [84]). The mainstream psychological literature has identified different types of insecure attachment such as avoidant, where people avoid close personal relationships; and anxious-ambivalent where people are 'clingy' and fear abandonment. Rholes *et al.* [100] found that avoidant people expressed both less desire to have children and stronger concerns about being a good parent than more securely attached people. Anxious-ambivalent

people were concerned about their capacity to be a good parent, but their attachment style was unrelated to their desire for children. A later study found that avoidantly attached people believed that their children would exhibit negative/insecure behaviour [101], while anxious-ambivalently attached people did not expect this. The authors speculate that, in line with Belsky [84], avoidantly attached people still have children despite low desire due to social norms, but offer lower parental investment.

McElwain *et al.* [102] discovered that attachment style is associated with two precursors to fertility, sexual risk taking behaviour and attitudes. Both anxious and avoidant groups were more inclined than securely attached individuals to believe in sexual relationships without commitment. These attitudes predicted sexual risk taking behaviour, with non-virgin males more likely to have more casual and unprotected sex. Securely attached individuals were more likely to reflect on their behaviour, and consequently take fewer sexual risks. This literature suggests that the tendency toward early fertility may be mediated by relationships between individuals and their early caregivers, potentially transmitting patterns down generations (see §6a).

An experimental study, grounded in *terror-management theory* (§3c), found that priming mortality salience increased both implicit and explicit parenthood-related thoughts, but only in participants low in avoidant attachment [60]. Avoidantly attached people may not use thoughts of relationships to buffer mortality-related emotional stress, although when primed with the notion that parenthood is compatible with career success, mortality salience elicited parenthood-related thoughts. Similar findings in career-minded women (see §6p) have been noted [59].

(f) Value of children

The value parents derive from children is generally positively associated with fertility [103]. Types of value gained from offspring cluster into psychological/emotional (e.g. offering the chance to receive love), economic/utilitarian (e.g. having someone to contribute economically to the family), and social/normative (e.g. having someone to continue the family name). Studying 28 years of Turkish history, Kagitcibasi & Ataca [104] found that as socio-economic development increases across time or place, there is less utilitarian/economic value attributed to children and a stronger emphasis on emotional benefits, with a concomitant change in sex preference from boys to girls. Moreover, a survey of adolescents from 12 high and middle income countries showed a decline in the utilitarian value of children with economic development [105].

(g) Sex ratio of mating pool

Male-biased populations favour female mate choice, with low socio-economic status men being less likely to find mates [61,62]. Conversely, female-biased populations favour male mate choice, producing less-stable unions, higher divorce rates, earlier reproduction in females and increased non-marital reproduction in females in more deprived areas. UK women's responses to female-biased operational sex ratios varied by women's current and childhood socio-economic status and reproductive strategy: high socio-economic status women with slow life-history strategies moved further towards the slow end of the life-history continuum and delayed reproduction, while low socio-economic status women with fast

life-history strategies favoured earlier reproduction [61]. Finnish women living in regions with male-biased sex ratios had earlier and higher fertility, but were no more likely to cohabit with a partner than women living in female-biased regions [62]. In Japan, female-biased sex ratios were associated with poorer union stability, shorter life expectancy, lower total fertility rates, and higher rates of spontaneous and artificial abortion [106]. Together, these studies [62,106] suggest that skewed sex ratios affect power in relationships: women have less power in female-biased populations.

(h) Relationship with partner

A number of studies indicate that relationship quality between a woman and her partner predicts feelings regarding progression to birth [12,107–109]. Wilson & Koo [107] surveyed low-income USA women and found that being in an established relationship, not having had a previous child with their partner, and having high expectations of emotional or financial support from their partner predicted higher desire for a child with him. Positive factors also included the knowledge that there would be a continued relationship with his relatives, even if the relationship ended. Carter *et al.* [108] found that, among young black and Puerto Rican people, in two USA cities, positive feelings about a potential pregnancy in their current relationship were associated with relationship length, frequency of sex, not having a previous child and partner's positive feelings about a pregnancy. Roberts *et al.* [110] also found that partner's interest in having children influenced men's fertility intentions, as did perceptions of their partner's suitability to parent. Rijken & Thomson [109] found that Dutch women's perceptions of relationship quality affected progression to first birth, whereas second birth progression is also affected by men's perceptions.

There may also be culturally enforced norms that discourage reproduction outside stable long-term relationships (§6m). Newson *et al.* [12] suggest that women look more positively upon pregnancy in others when that other woman is in a secure and committed relationship with a supportive husband, rather than single or with an unsupportive husband.

(i) Reproductive autonomy

Low female reproductive autonomy is associated with higher fertility [111]. One reason for this may be that women with low power within their relationship are less able to initiate contraceptive use [48]. Women having low power within their relationships may be associated with female-biased population sex ratios [62,106]. Meanwhile, greater female reproductive autonomy is associated with greater ability and acceptance of women in the workforce. Straits [47] found, through hypothetical vignettes, that women's long-term fertility preferences were dominated by their employment opportunities, and that fertility preferences change with inter-cohort shifts in values and expectations of women. A number of studies found that both male and female participants who favoured traditional female gender roles had higher fertility desires [24,28,73]. Reproductive autonomy is also addressed in §§5b,c and 6g.

(j) Paternity and maternity uncertainty

Paternity uncertainty is negatively associated with men's degree of parental investment [112,113]; and, more generally, unrelated children in a household (e.g. stepchildren) are more

likely to be victims of abuse and neglect [112,114,115]. Research using hypothetical vignettes in which a subject was either unrelated to a baby, or the baby's other parent was not who the subject expected, suggests women respond more negatively than men to discovering a child is unrelated to them, but are more likely to continue investing in that child regardless of relatedness [116]. Hill & DelPriore [55] found that cuing jealousy encouraged concerns about partner infidelity, decreasing interest in infants and parenting interest among chronically jealous men and women, and decreasing desired parental investment among chronically jealous men. Jealousy may function to minimize costs associated with paternity uncertainty among men, and loss of resource investment among women.

(k) Cooperative breeding and kin support

Chipman & Morrison [65] found that access to grandparental investment increased propensity for sexual risk taking, and reduced preferred, and realized, age at first birth. Waynforth [117] found that, among a British cohort born in 1970, financial dependency on parents delayed and limited reproduction, but being close to parents and seeing parents frequently increased reproduction between ages 30 and 34 years. Time-based kin support may be more important than resource-based kin support in encouraging fertility.

Newson *et al.* [12] found that women reading vignettes in the role of the protagonist's 'mother' were more supportive of the protagonist's reproduction under situations of positive resource access than women reading in the role of the protagonist's 'friend'. 'Mothers' were also less supportive under negative resource situations than 'friends', suggesting the value of resource access and social support are salient factors in fertility planning. Miller *et al.* [2] suggest that women need help from others to support their expensive offspring, and that this is facilitated by evolved adaptations that encourage close and enduring relationships among adults. Chasiotis *et al.* [83] suggest that we are predisposed to parental attachment and care due to evolved mechanisms of nepotistic altruism. The importance of paternal parental care, especially father absence (§6c), is often discussed in terms of daughter's sexual risk taking [21,53,70,86].

Auspurg *et al.* [38] asked subjects to think about their social networks before answering questions on their fertility intentions. They expected thinking about their close social network to prime subjects to expect informal 'free' childcare from network members, reducing the perceived cost of children and encouraging higher fertility intentions. However, no effect of priming social networks on fertility intentions was found.

(l) Cost of children

The cost of having children, both perceived and real, is positively associated with age at first birth and inversely related to fertility [31,118,119]. Using vignettes, Straits [47] found that women approved of wealthy families having more children and disapproved of continued reproduction in poorer families. Attitudes toward reproduction in wealthy families became less favourable as parity increased, suggesting that the direct cost of children is a salient theme in fertility decision-making. Kariman *et al.* [120] also found that, among Iranian women, financial security, and securing their own and their children's futures, were primary concerns of

childbearing. In Portuguese men and women, economic concerns were also a salient issue [71].

Straits [47], also considered the indirect costs of children (e.g. career-childbearing conflicts), which were found to be less salient than direct costs: most women favoured motherhood over career advancement. These effects were tempered by perceived cultural support of parenthood. Supporting this, in female academic staff and students, Aarssen & Altman [10] found a small inverse correlation between desired fertility and interest in goals, including having a rewarding career.

In a Swedish sample, concerns about career-childbearing conflicts explained childlessness in men and women in their late 20s and early 30s [76]. This was less prevalent among older childless Swedes where the loss of independence was a major concern. Among a random sample of USA women, those avoiding pregnancy were more concerned about economic hardship and career success than women who were trying to get pregnant [74]. Among childless married couples in the UK, reasons for childlessness included concerns about interference with career, and strain on relationship and self [121]. Childbearing does have positive connotations that may outweigh costs, e.g. socio-economic support, strengthening relationships and continuity [71,121]

Under mortality priming, subjects tended towards perceiving children as less costly [58]. Moreover, in undergraduates, the psychological cost of childrearing was not affected by attachment style (§6e) or gender [100]. Child cost is also discussed in §6k.

(m) Cultural norms

Cultural norms are addressed in terms of modelling peers' fertility behaviour, meeting behavioural expectations of significant others, preferring culturally sanctioned normative rather than deviant behaviour, and how population-level shifts in expectations of women affect fertility. Adair [28] found that participants integrated information about fertility timing from their peers' fertility behaviour. Similarly, in a large European sample, subjective fertility norms and the influence of important others were associated with fertility intentions [24]. Strikingly, Ajzen & Klobas [8] found subjective norms influenced fertility intentions in seven out of eight developed countries studied.

Straits [47] proposed that fertility decline is due partly to decreased cultural support for parenthood and found, using vignettes, that fertility change is linked to inter-cohort shifts in values and expectations of women: fertility declined if there was less cultural support for motherhood and more cultural support for women's career investment. In line with this, Kariman *et al.* [120] found that childbearing among Iranian women is influenced partly by social pressure to reproduce and conflict with employment. Adair [28] also found evidence that values and expectations of women affect fertility: (i) couples with traditional views on female roles had more positive attitudes towards babies than couples with more work-orientated views; (ii) women who experience more cultural pressure to have children had younger preferred ages at first birth; and (iii) relationship status affected fertility desires, attitudes and plans—men and women not in relationships had more negative attitudes towards babies, later preferred ages at first birth, and smaller preferred completed family sizes. Adair's [28] latter finding links with Miller's [64] work, which suggests that single

women are motivated by culture norms to only reproduce within stable unions. Newson *et al.* [12] suggest that women are more approving of new pregnancies in women who are within culturally sanctioned norms.

The tension between cultural norms and individual biological drives should be noted. For example, the *baby fever* literature (§5d) suggests that baby fever can occur in late teens to early 20s in Western women, despite prevailing cultural norms and expectations for women to delay reproduction until an education and career have been attained [72].

(n) Religiosity

Religious beliefs and rules about contraceptive use, abortions, gender roles and the importance of the family are associated with fertility rates [120,121]. Greater religiosity and religious activity are associated with higher fertility [122–125]. Aarssen & Altman [10] found a positive correlation in females between desired fertility and the goal of inspiring others with one's religious belief. Gray *et al.* [75] found that men with lower religiosity had lower fertility desires. Philipov *et al.* [24] consider religion to be an important background factor affecting people's attitudes, subjective norms and perceived behavioural control of fertility: for example, religiosity may encourage higher fertility in those who believe a higher power will provide for them if needed.

Eurich [39] theorized that Christians are more sexually restricted and place greater emphasis on parenting. Thus, priming subjects' Christianity should decrease promiscuity and increase valuation of children. More notable effects of priming Christianity in men than women were expected, as women generally seek short-term mates less often than men, so have less room to show variation than men. Priming for Christianity decreased reports of promiscuity, but did not impact partner preferences or parenting motivation, and there was no gender difference.

(o) Resource stress and limitation

Using experimental methods, the effects of resource stress and limitation on fertility have largely been explored through the lens of *life-history theory* (§3b). Van der Wal *et al.* [43] found that when cued with photos of a natural environment, subjects perceived resources to be plentiful and competition low. When cued to urban environments, participants perceived resources to be scarce and competition high. Natural environment cues may encourage a slower life-history strategy, e.g. lower fertility but greater parental investment per child, and urban environments a faster life-history strategy, e.g. higher fertility and lower parental investment per child. Li *et al.* [126] found university students in Singapore primed for materialism had more negative attitudes toward children and desired fewer children than students not primed for materialism.

Griskevicius *et al.* [45,54] found no effect of current socio-economic status on attitudes towards reproduction, but instead strong effects of childhood resource stress (see §6b,p). Hill *et al.* [46,56] found that childhood socio-economic status affected people's behaviour in resource-stressed environments as adults. Participants' life-history strategies appeared similar under benign conditions. However, when cued for environmental harshness (resource scarcity or high mortality (§6o,p)), men and women calibrated to fast life-history strategies preferred larger women—those better able to sustain a pregnancy and maternal investment with limited access to

resources—compared with those calibrated to slow life histories [56]. When cued for harshness, fast life-history women had increased interest in food and weight gain, and reduced interest in dieting, while slow life-history women had reduced interest in food and increased interest in weight loss and dieting—consistent with contingent expression of a slower life-history strategy and facilitating delayed reproductive goals through subfecundity.

A number of vignette studies suggest reproduction in women with unstable or poor access to resources is disapproved of or considered deviant behaviour [12,36]. Resource stress is also associated with *mating preferences and choice* (§5a). Cohen & Belsky [51] primed participants for environmental predictability. Women cued for predictably safe and resource-rich environments desired longer-term relationships. They also valued partners who were sexually faithful and interested in long-term relationships and parental investment, more than women who were cued for environments that fluctuated between safe/resource-rich and risky/resource-poor environments, or women cued for predictably-risky and resource-poor environments. Little *et al.* [40] found that under ecologically harsh conditions, men and women favour low-quality/high-investment partners for long-term relationships. For short-term relationships, where investment is unimportant, high-quality partners were favoured regardless of ecological condition. The influence of resource stress on fertility behaviour and attitudes towards women who reproduce under resource-poor conditions are also discussed in §6b,c,g,h,k–m.

(p) Mortality risk and salience

Correlational evidence suggests that mortality risk is inversely related to age at reproductive maturity and first birth [78,79,127–129] and positively associated with fertility [77,130,131]. This is supported by a growing body of research, using experimental methods, that suggests encouraging people to think about death increases childbearing motivation. This evidence comes mostly from psychological experiments inspired by *terror-management theory* [6,41,42,60] and *life-history theory* [45,46,50,52,54,56,63].

Chipman & Morrison [65] found that perceptions of low local life expectancy and high risk, lead adolescents to have more positive attitudes toward teenage pregnancy. Griskevicius *et al.* [45,54], using experimental methods, found a similar relationship among USA undergraduates—an effect moderated by childhood socio-economic status (see §6b). Participants raised in subjectively poorer economic environments, when primed with a high mortality risk cue, had more positive attitudes toward having children earlier in life [45], and were more present oriented and willing to take risks [54], than participants in the control groups. Participants raised in wealthier socio-economic environments, when primed with a high mortality risk cue, had more negative attitudes towards reproducing earlier in life [45], and were more future oriented and cautious [54], than controls.

Wisman & Goldenberg [59] found that mortality salience triggered a desire for more offspring in Dutch men and a non-significant trend for wanting fewer children in Dutch women. This gender difference may have resulted from career-childbearing trade-offs, as women primed with information that the two were compatible echoed the male results. German undergraduates were more likely to say they wanted at least one child, and were more likely to use

offspring-related words after mortality priming compared to controls [57]. There was no sex difference in the effect, possibly because people were asked only if they wanted children at all, rather than how many. Mortality salience is also considered by Yaakobi *et al.* [60] in relation to how, with attachment style, it may influence interest in parenting (§e).

In China, Zhou *et al.* [6] discovered that people primed with mortality were more disapproving of the one-child policy than controls. They also found that terminally ill hospital patients showed greater preferences for family members under 5 years (versus older family members) in comparison with a non-terminally ill patient group. Follow-up work by Zhou *et al.* [41] showed that students instructed to think about death preferred pictures of young children and viewed them longer than pictures of adults or objects.

Taubman-Ben-Ari & Katz-Ben-Ami [42] discovered that, in an Israeli sample, priming mortality salience induced higher maternal separation anxiety compared with a control group, but contrary to predictions this did not interact with attachment style. Mathews & Sear [58] found that males primed with mortality salience had a higher ideal number of children, but no such effect for females.

In vignette studies, people exposed to the idea of shorter life expectancies were more willing to sexually coerce a partner, had more aggressive and less generative (desire to positively influence future generations) tendencies [49,50,52]. For both sexes, cuing a shorter life expectancy increased preference for short-term mating, and cuing a longer life expectancy increased preference for long-term mating. Furthermore, Hill *et al.* [46,56] found, when primed for high mortality in their local environment, men's and women's facultative life-history strategies moderated their female body size preferences (see §6o).

Pepper & Nettle [132] suggest bereavements may be real-world cues of mortality risk. They found, through an Internet survey of North Americans, an association between number of close bereavements within the past 5 years and a lower ideal age at first birth, increased hazard of actual first birth, and steeper financial future discounting.

7. Issues with experimental methods

Studies using experimental methods, such as priming, are forerunners in an emerging field; however, studies to date have had several limitations. First, subjects are typically from WEIRD populations (figure 2) that tend to have low population fertility rates [37]. Future work should extend priming studies to other populations, especially those which have yet to complete the demographic transition. This will help to address questions about the universality of the cues and psychological mechanisms influencing human fertility.

Second, despite partitioning mortality risk and resource scarcity, priming studies have yet to address what components of these environmental cues we are attuned to. An exception may be a study on the effects of father absence [53]: just thinking about an important time in their lives when their fathers were absent encouraged sexual risk taking in women (§6c). Future work should aim for greater specificity of the environmental component being primed (e.g. infant or adult mortality).

Third, most priming studies use written media for the prime. The ecological validity of this, compared to more

naturalistic media, is questionable (see [43] for an exception using natural environments). Written media also suffers in translation and is inappropriate for work in non-literate populations, making cross-cultural comparisons difficult. Some researchers have employed photographs suggesting higher mortality risk or resource scarcity [43,46]. However, the cross-cultural validity of image contents are disputable. Other studies have used pre-questions to prime mortality risk [58]: subjects were asked questions about their perceptions of local mortality risk before answering questions about their reproductive preferences. However, these stated perceptions are likely influenced by conscious decision pathways and cultural norms. Future work should aim to develop primes that have strong cross-cultural validity.

Fourth, with psychological experiments we are limited to altering individuals' perceptions of their environment and measuring their preferences: their realities remain unchanged and their future reproductive behaviour unknown. However, preferences are strongly linked to intentions which, in turn, are associated with behaviours [111,133–138].

Fifth, although some priming research has acknowledged that childhood stress likely initiates changes in individual psychology that moderate responses to cues of current environmental harshness in adulthood, the pathways remain poorly addressed.

Nevertheless, experimental methods that alter perceptions can be effective. Perceptions are known to affect life-history strategies [139], and may be more influential than reality in some instances [140]. Furthermore, if our underlying goal is to piece together how the psychological mechanisms influencing our fertility function, the key is understanding how humans perceive and internalize their reality.

8. Conclusion

This paper discussed the breadth of research on the psychology behind human fertility. This research has been grounded in numerous theoretical perspectives. It should be noted that these theories, though presented in silos, may represent different explanatory levels of a larger, more nuanced account. The ultimate level of explanation might include *life-history theory*, the *transmission competition hypothesis* and *terror-management theory*. These theories all strive for evolutionary explanations and are not mutually exclusive. For example, *life-history theory* assumes fertility is sensitive to mortality risk. High fertility may be simultaneously encouraged by an evolved desire to leave descendants, which both the *transmission competition hypothesis* and *terror-management theory* address. The overlap between *life-history theory* and *terror-management theory* is a common debate in the literature [45,57,59]. At a more proximate and mechanistic level are the *theory of planned behaviour* and the *traits–desires–intentions–behaviours* framework. Both speak, with noticeable overlap, to how intentions form and lead to behaviours [141].

Given that research has crossed multiple disciplines, the lack of a single coherent theory for the psychology of human fertility is not surprising. Moving forward, discussions that bring together researchers from across disciplines and theoretical backgrounds will be key.

Researchers have suggested numerous factors that may influence human fertility including: heritable components, childhood environment, personality, access to kin support,

cost of children, cultural norms, resource stress and mortality risk. Most research on the underlying psychology of human fertility has been correlational and cannot confirm causal relationships. However, a growing literature of experimental work does support many of the proposed causal relationships and pathways.

Using experimental methods researchers have found support for: *childhood stress* (§6b) and *father absence* (§6c) lowering preferred age at first birth and increasing sexual risk taking [45,53]; *attachment style* (§6e) influencing parenthood-related thoughts [60]; *cultural norms* (§6m) discouraging reproduction outside stable unions [12]; *women's reproductive autonomy* (§6i) influencing their fertility preferences [47]; *paternity uncertainty* (§6j) discouraging parental investment by men [55]; *high cost of children* (§6l) encouraging delayed reproduction and lower fertility [36,47]; *resource stress and limitation* (§6o) affecting mating preferences [12,36,40,51]; and *mortality risk and salience* (§6p) encouraging a greater interest in children, earlier reproduction and higher fertility [6,41,42,45,57–59]. However, it should be noted that some of this support is mixed. Research using experimental methods found no support for *cooperative*

breeding and kin support (§6k) [38] or *religiosity* (§6n) [39] affecting how many children participants wanted to have [38].

In summary, experimental work may be a shining light in research on human reproductive decision-making, helping to separate causal pathways, and their associated cues, from the sea of correlative evidence. However, more research and methodological fine tuning is needed to achieve this goal.

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