Violence, teenage pregnancy and life history: Ecological factors and their impact on strategy-driven behaviour.

Lee T. Copping

Department of Psychology

Durham University

Queens Campus

University Boulevard

Thornaby

Stockton-on-Tees

United Kingdom

TS17 6BH

E-mail: l.t.copping@durham.ac.uk

Anne Campbell

Department of Psychology

Durham University Science Site

South Road

Durham

United Kingdom

DH1 3LE

E-mail: a.c.campbell@durham.ac.uk

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Abstract

Guided by principles of life history strategy development, this study tested the hypothesis that sexual precocity and violence are caused by sensitivities to local environmental conditions. Two models of strategy development were compared: The first is based on indirect perception of ecological cues through family disruption and the second is based on both direct and indirect perception of ecological stressors. Results showed a moderate correlation between rates of violence and sexual precocity, r = .59. Whilst a model incorporating direct and indirect effects provided a better fit than one based on family mediation alone, significant improvements were made by linking some ecological factors directly to behaviour independently of strategy development. The models support the contention that violence and teenage pregnancy are part of an ecologically determined pattern of strategy development and suggest that, whilst the family unit is critical in affecting behaviour, individuals' direct experiences of the environment are also important.

Introduction

Violent crime and teenage pregnancy represent not only challenges to society, but to those who attempt to explain their aetiology. This study examines whether these social phenomena share common origins in the social structure of a person's environment, based on the idea that both may represent adaptive behavioural alternatives rather than symptoms of pathology.

There is a significant correlation between aggression and early reproduction: aggressive individuals tend to be more sexually precocious and active (Xie, Cairns, & Cairns, 2001). In females, early maturation is associated with earlier sexual behaviour and heightened aggression (Celio, Karnik, & Steiner, 2006). Girls with conduct disorder are also at greater risk from teenage pregnancies (Woodward & Fergusson, 1999). In males, mating effort (preference for short-term sexual relationships over long-term relationships) is related to antisocial behaviour (Lalumiere & Quinsey, 1996; Rowe, Vasonyi, & Figueredo, 1997) and serious delinquents are more likely to have sex early, impregnate partners and father children by age nineteen than those with less serious delinquency records (Wei, Loeber, & Stauthamer-Loeber, 2002). Teenage fathers are more likely to engage in criminal behaviour (Elster, Lamb, Peters, Kahn, & Tavare, 1987). Homicides and adolescent birth rates are strongly correlated internationally, $r = .95$, and within the USA, $r = .74$ (Pickett, Mookherjee, & Wilkinson, 2005).

Environmental correlates of early pregnancy and violence have been investigated for many years. Established relationships between these phenomena suggest common etiological origins. However, studies rarely look simultaneously at aggression and early reproduction as dependent variables within the same investigation, leaving potential common etiological origins unexamined. A

summary of frequently investigated social and environmental correlates of aggression and early reproduction that could represent such commonalities follows.

Economic deprivation is the most commonly researched correlate of aggressive and early reproductive behaviour. Aggression, child maltreatment, violent crime and juvenile delinquency are all significantly predicted by impoverishment measured as a composite variable from unemployment rate, poverty rate, and vacant housing (Coulton, Corbin, Su, & Chow, 1995). Intimate partner violence (Cunradi, Caetano, Clark, & Schafer, 2000) and lethal violence (Huff-Corzine, Corzine, & Moore, 1991) are both related to poverty, defined by low annual household income. Income inequalities across cultures are also related to increased levels of violence and teenage pregnancies; societies with wider income gaps demonstrate higher violence and higher teenage conception rates (Wilkinson & Pickett, 2009). Early sexual activity and pregnancy are significantly correlated with the number of girls classed as impoverished in urban localities (Brewster, 1994; Lanctot & Smith, 2001). Teenage fathers are significantly more likely than older fathers to have lower incomes (Tan & Quinlivan, 2006).

Measures of *family breakdown* are frequently correlated with aggression and early reproduction. Demographic studies note the strong correlation between divorce rates and aggression (Blau & Blau, 1982; Land, McCall, & Cohen, 1990). The likelihood of homicide victimization increases with the percentage of female-headed households within a locality (Dobrin, Lee, & Price, 2005). Coulton et al.'s (1995) analysis demonstrated that the number of female-headed households strongly correlates with neighbourhood violence rates. Associations between family breakdown (operationalized as parental separation, parental abuse, father absence etc.) and early sexual/reproductive onset have also been documented (Belsky, 2007; Chisholm, 1999a; Ellis, 2004; Ellis, Bates, Dodge, Fergusson, Horwood, Pettit & Woodward 2003; Ellis & Essex, 2007).

Allied to poverty, *lack of education* elevates rates of aggression and early reproduction. Violence levels are lower in areas with more high-school graduates (Dobrin et al., 2005). Schools with lower academic performance and lower staff-pupil ratios have higher pupil crime rates (Limbos & Casteel, 2008). Better education and academic achievement also appear to be protective factors against early sexual activity (Hallett et al., 2007; Laflin, Wang & Barry, 2008; Quinlivan, Tan, Steele & Black, 2004).

Neighbourhood *age and population structures* have implications for aggressive behaviour because criminal involvement peaks between the ages of 16 and 30 (Steffensmeier, Allan, Harer, & Streifel, 1989). The number of people aged 15 to 29 in large metropolitan areas is predictive of homicide rates (Land, McCall & Cohen, 1990). The age-crime curve is usually attributed to the fact that younger people have fewer resources despite being at their physical reproductive peak (Moffitt, 1993). Individuals therefore resort to risky strategies (including crime) to accrue more resources. This is especially true for males, a phenomenon that Daly and Wilson (1985) refer to as "The Young Male Syndrome". Higher concentrations of youths competing for resources raise encounter rates between them, and consequent violence. Relationships between age structure and reproduction are less clear. Research suggests that population density has no effect on teenage pregnancy and live birth rates (Barbieri, 2004; Gawryszewski & Costa, 2005), although the opposite is true for aggression (Land et al., 1990). If the logic of the age-crime effect were applied to sexual activity, higher concentrations of youths would be expected to increase early reproduction rates. Males and females between the ages of 16 and 30 are in their reproductive prime and thus, increased encounter rates between them would be expected to increase the frequency of copulations and early pregnancies.

Sex ratios are the ratio of males to females within a locality: high ratios denoting an excess of males. South and Messner (1987) showed that an excess of women increases female crime rates.

Barber (2000a) demonstrated cross-culturally that low sex ratios predicted higher homicide levels. Messner and Sampson (1991) reached similar conclusions examining 153 American cities. Similar effects of sex ratio have been demonstrated for early reproduction; low sex ratios being associated with higher rates of teenage pregnancy (Barber, 2000b). Guttentag and Secord (1983) proposed that, in societies with excess women, women's consequent loss of marriage market control would be characterised by broken homes, female-headed households, unsupervised children and increased violence. Children growing up in households characterised thus would develop similar reproductive strategies themselves.

Few theories explain how and why these ecological factors are relevant to both behaviours. Contemporary evolutionary science offers a framework in which relationships between aggression, sexual precocity and environmental factors can be reconciled: Life History Theory (LHT). LHT suggests that resources necessary for survival and reproduction available to organisms are finite. Consequently, tradeoffs are made between potential investments (see Kaplan and Gangestad (2005) for a review of LHT). One trade-off is between current and future reproduction (Schaffer, 1983); the choice between earlier reproduction at the cost of lower investment and possible deleterious health problems in offspring (e.g. low birth weight; Coall & Chisholm, 2003) or delaying reproduction until conditions are sufficient to enable higher parental investment at the cost of losing a proportion of reproductive lifespan. Trade-offs also emerge between reproductive quality and quantity. More children mean that resources have to be stretched, with lower investment in each, and poorer quality offspring that may be disadvantaged for future reproduction. Alternatively, having one child and investing heavily in it entails risk; if it dies, potential future descendants die with it. Should it survive however, it has a greater reproductive advantage when it reaches maturity. Trade-offs determine an organism's Life History Strategy; clusters of behaviours that guide organisms towards achieving maximum reproductive fitness in the environments in which they develop. Many postulate

the existence of a fast/slow continuum of behaviours geared to this end. Cross-species research consistently shows that earlier reproducing species are more aggression-prone than those who reproduce more slowly (Eisenberg, 1981), suggestive of a faster LH strategy.

A crucial aspect of LHT is the identification of the specific environmental cues that trigger strategy selection and the mechanism by which this is achieved. Studies in LHT imply that cues suggestive of shortened life expectancy (such as high morbidity/mortality) drive strategy selection toward the fast end of the continuum (Brumbach, Figueredo & Ellis, 2009; Chisholm, 1999; Ellis, Figueredo, Brumbach & Schlomer, 2009). Those living under conditions of high mortality are more likely to die young and develop behavioural strategies to avoid lineage extinction. Women reproduce earlier and more often, reducing investment in offspring. Despite poorer offspring quality, their numbers increase the probability that one or more will survive to reproduce. As reproductive fitness in males is often dependent on resource holding potential, males can increase their resources and status through within-sex competition. Aggression demonstrates strength, bravery and survivorship, increasing their desirability as partners whilst depriving competition of status and resources. Individuals living in ecological conditions of high mortality are therefore more likely to demonstrate higher rates of violence, crime and sexually precocious behaviour. Research confirms such relationships. Violence by young, black adolescents was negatively related to the belief that they would live to age 25; the effect being stronger for men than for women (DuRant, Cadenhead, Pendergrast, Slavens, & Linder, 1997). Homicide and age of first birth were strongly related to life expectancy in Chicago's urban neighbourhoods (Wilson & Daly, 1997). Interviews of members of a black community in the United States showed that ninety-one percent of women did not expect to live beyond age sixty, and that the transition to early motherhood was part of an accelerated family timetable calibrated to their assessment of life expectancies (Burton, 1990).

A key question is what environmental cues convey to individuals the likelihood of a short life expectancy and by what evolved mechanisms are these cues perceived? Two models have been proposed. In one, short life expectancy is signalled indirectly through disrupted family functioning. In the other, it is inferred both directly and indirectly from cues about quality of life in the local environment. We consider these in turn.

Draper and Harpending (1982) were among the first to highlight the importance of family functioning and its effects on reproductive strategy, specifically, the effects of father absence. They argued that females growing up in father absent environments adopt reproductive behaviour profiles calibrated to an anticipated future of unstable pair bonds and inconsistent or absent paternal investment in childrearing. Belsky, Steinberg and Draper (1991) developed this proposal by clarifying the evolved mechanism that calibrated future reproductive strategy. They suggested that the family environment as a whole was crucial to the behavioural, social and emotional development of children. Environmental uncertainty and attendant stress disrupt familial functioning, damaging bonds between parents and children and disrupting the attachment process (Bowlby, 1969, 1973, 1980). An insecurely attached child adopts an internal working model (IWM) of relationship uncertainty via their experience of parent-parent and parent-child interactions. These cues convey that the future is uncertain and serve to accelerate pubertal onset and early sexual debut as part of adopting a reproductive strategy suited to an uncertain ecological context. Chisholm (1993, 1999b; Chisholm & Burbank, 2001) added to this model of development by proposing specific mechanisms. Firstly, he suggested that the IWM determines a child's time preference. Time preference is an economic term, synonymous with psychological constructs such as time horizon, delay of gratification and impulsivity. Individuals with shorter time preferences favour short-term consumption and reproduction rather than long-term investment, devaluing the future relative to the present and altering reproductive schedules accordingly. Secondly, Chisholm unites parental

stress with mortality, suggesting that "ultimately, universal sources of parental stress are the routine social and environmental causes and correlates of high mortality rates --- poverty, exploitation, hunger, disease, and war and their accompanying fear and hopelessness" (Chisholm, 1993:7). The key component of this argument is that wider environmental conditions are signalled to developing children through the stability or instability of the family unit and that this signal conveys expectations regarding their expected length of life. Chisholm, Quinlivan, Peterson and Cole (2005) supported this model in a cross-sectional study showing that in women, early stress (indexed by parental conflict and father absence) correlated significantly with age of menarche, age of first birth and expected lifespan. Schwartz, Friedman, Tucker, Tomlinson-Keasey, Wingard, & Criqui (1995) demonstrated that childhood stress, indexed by parental divorce before age twenty-one, was associated with a forty-four percent increase in early mortality risk. Other indices of family breakdown were associated with mortality risk at about half of this strength. Prospective studies have also reported positive relationships between indices of family breakdown (especially father absence), aggression, criminality, early menarche and sexual debut (Belsky, Schlomer & Ellis, 2011; Carrasco, Holgado, Rodriguez & del Barrio, 2009; Ellis & Essex, 2007; Gibson & Tibbetts, 2000; Moffitt, Caspi, Belsky, & Silva, 1992; Su, Simons & Simons, 2011).

Ellis et al. (2009) offer a potential alternative mechanism. Although acknowledging the fundamental proposals of Belsky et al., they argue that individuals have evolved sensitivities to environmental cues pertaining to morbidity-mortality risks and stochastic variations in ecological conditions that can exert influence beyond the family unit; the presence of such cues uniquely contributing to the development of LH strategies. Ellis et al. propose that unpredictable developmental environments create internal unpredictability schemas; mental models representing the chaotic, unpredictable nature of both other organisms and the environment (see also Ross & Hill, 2002). By adopting unpredictability schemas, individuals become present-oriented with an

accompanying increase in risk taking behaviours. Unpredictability schemas may act as a "mediating mechanism through which exposures to stochastic conditions shift individuals toward faster LH strategies (Ellis et al 2009:249)". Daly and Wilson (1997) drew similar conclusions, claiming that the mind unconsciously generates statistical composites of local mortality rates based upon observations of local populations. Evolution may have equipped the psyche to perceive changes in local mortality rates and calibrate LH strategies. Environmental cues are registered by individuals through multiple pathways and are likely to be interrelated, to operate on multiple levels and have a hierarchical influence on strategy development. Accordingly, whilst still being receptive to environmental cues pertaining to morbidity and mortality, individuals will also remain sensitive to how the same cues affect parents and subsequent parental investment. Ellis et al. (2009:254) argue that "The fact that environmental harshness and unpredictability, and their various moderating conditions, operate in an interrelated manner— meaning that just knowing one of these environmental dimensions does not afford accurate prediction of evolution or development—necessitates substantial consideration of each". What cues convey information about expected morbidity and mortality? Ellis et al. (2009) suggest low socioeconomic status, poor physical health, involvement in or victimisation from conspecific violence, indicators of neighbourhood deterioration and poor quality parental investment. To summarise "shorter life expectancies/higher mortality rates as indicated by the conditions of people's lives that reliably forecast premature aging or death facultatively accelerate LH strategies" (Ellis et al., 2009:247). Support for this model was reported by Brumbach et al. (2009), demonstrating that indices such as exposure to violence, lack of parental care and familial contact with social services were linked to LH traits in adolescence and young adulthood and that strategies are coherently formed by the time individuals reach their twenties. A longitudinal study (Simpson, Griskevicius, I-Chun Kuo & Sung, in press) found that sexual and criminal behaviour at age twenty-three was predicted by the level of unpredictability experienced by

age five (indexed by changes to mothers residence, employment and partners). Belsky et al. (2011) demonstrated similar results; focusing on sexual behaviour at age fifteen as the dependent measure.

In the present study, data from the England and Wales Census (2001) was used to examine indices of neighbourhood quality and family structure in relation to violent crime and teenage pregnancy. Analysis was guided by the following research aims. Firstly, to confirm the relationship between violence and early reproduction. Secondly, to determine which environmental factors are predictive of violence and early reproduction. Thirdly, to explore if environmental factors have both direct and indirect effects on these outcomes, as suggested by Ellis et al. (2009), or are mediated predominantly by family disruption (Draper & Harpending, 1982; Belsky et al., 1991; Chisholm, 1999a).

Method

Sample

Data from three hundred and thirty-nine local authorities[1] were collected online from the England and Wales Census (2001). The data from these areas covered 46,371,315 people in total. Local authorities (responsible for administering health, education, public safety and other government services over a geographic area) were selected as the unit of analysis, with no exclusion based on population size, for two reasons. Firstly, it was the smallest level of analysis from which all necessary data could be extrapolated from government figures. Secondly, the study aimed to disaggregate the nation into the smallest possible units in order to represent local environments as sensitively as possible.

Measures

[1] 13 out of 352 authorities were not included due to differences in their administration.

Theoretically relevant variables from the Census were selected. Variables were selected on the basis of reflecting aspects of uncertainty, including characteristics of the local population structure. Data points were converted into either percentages of the population, or rates per 1000 to allow comparison whilst controlling for population size. Variables assessed the following domains:

Number of Youths: The number of youths (both sexes) between the ages of fifteen to twenty-nine was summed and calculated as a rate per 1000 of the population to create a single measure.

Youth Sex Ratio: It has been suggested by some (Barber, 2001) that the sex ratio of males and females of reproductive age is the most significant form of population sex ratio related to aggressive and sexually precocious behaviour. This ratio was calculated as the number of males per 100 females of the population aged 15 to 29.

Father absence: The measure of family breakdown used in this study was the rate of Female Lone Parents (per 1000 female adults). This was deemed theoretically appropriate given the body of research on the effects of father absence (Belsky et al., 1991, Draper & Harpending, 1982)[2]. Given the nature of the census data, we were unable to assess psychological aspects of family functioning (e.g. attachment, conflict).

Education: Educational attainment measures were recorded from the Census, specifically, the percentage of pupils achieving at least level 5 in English, Mathematics and Science. The British government's National Curriculum expects pupils to reach a minimum of Level 5 academic performance by approximately the age of fourteen. Because multiple indices were coded in relation to the *Education* variable, Principle Components Analysis was used to determine if the three indicators loaded onto one latent factor. One factor explaining ninety-four percent of available

[2] We note however that this measure may include households where the father visits, where the mother cohabits with a male partner and where children experience stable mother-only environments.

variance emerged. Internal consistency (Cronbach's alpha) of this scale was high at .97. Factor loadings ranged between .90 and .96.

Unemployment: This was indexed by the rate of jobseekers per 1000 adults.

Life Expectancy: Indices of life expectancy were recorded in the form of male and female disability-free life expectancy from birth. These were summed and divided by two to give an approximate measure of overall disability-free life expectancy. Disability-free life expectancy assesses the estimated years of life individuals can expect to have in good health and without physical or mental disability. This was deemed more theoretically appropriate than simple life expectancy given that poor health reduces the amount of available lifespan available to invest in parenting or reproduction (Ellis et al., 2009; Nettle, 2010) and would thus impact upon LH traits.

Population Density: This was indexed by the number of people per hectare.

Two dependent variables were used in this study, both extracted from census data. *Teenage Conception Rate* was indexed by the number of teenage pregnancies in females between the ages of 15 and 17[3] (calculated as a rate per 1000 for the census year). *Victimful Criminality* was indexed by summing the number of crimes from the following police categories; violence against the person, wounding or life endangering acts, other wounding offences, harassment and penalty notices for disorder and common assault. These all represent acts that involve aggression towards another individual[4]. This summed figure was then converted into a rate per 1000 of the total adult population for the census year.

[3] Teenage conception rates cover ages 15 to 17. Data on pregnancies at earlier ages are confidential and not recorded by local authorities. The actual number of teenage pregnancies in each local authority is therefore likely to be higher than recorded here.

[4] Homicide data were not obtainable at local authority level and so the Victimful Criminality score does not include it. Future works should attempt to integrate these figures if they become accessible.

Results

Descriptive statistics for all variables are presented in Table 1. Table 2 presents the intercorrelations between the predictor and outcome variables. *Victimful Criminality* and *Teenage Conception Rates* correlate positively and significantly, r = .59 ($p < .01$), confirming the expected relationship. Moderate to strong correlations exist between all independent variables and the two dependent variables (the exception being *Youth Sex Ratio* which is significant only with *Teenage Conception Rate*). These correlations are all in the same direction, suggesting that violence and teenage pregnancies rise and fall together in response to changes in ecological indicators (the exception again being *Youth Sex Ratio*).

Ecological threats: Father absence as a mediator or direct perception?

According to Belsky et al. (1991) and Chisholm (1999), ecological factors impact upon father absence which in turn affects violence and early pregnancy. Ellis et al. (2009) however suggest that direct as well as indirect perception of these ecological conditions is also possible. Structural Equation Modelling (SEM) was used to evaluate both proposals. Two SEM models were constructed to determine which model gave a better fit to the data. A latent variable (labelled "*Strategy*") was used to represent the hypothesised relationship between the two dependent variables. The two models are illustrated diagrammatically in Figures 1 and 2. In Figure 1, links between the independent variables and the *Strategy* variable are both direct and indirect (through father absence) thus representing the Ellis et al. conceptualization. In Figure 2, the direct linkages are constrained to zero in order to examine only the mediating effect of father absence. Fit statistics are reported in Table 3.

The models were applied to the whole sample and then compared. Observed variables are represented by rectangles and latent variables by ellipses. It should be noted that, for modelling

purposes, all predictor variables were assumed to be correlated although, for reasons of clarity, these paths are omitted in the diagrams. Residual symbols (measurement error) and pathways constrained to zero are also omitted to aid interpretation. Coefficients for pathways represent standardised regression weights. All models were generated using Maximum Likelihood Estimation. Models were evaluated using several fit indices. A Chi-square test examines the significance between the restricted covariance matrix and the unrestricted sample covariance matrix. Significant p values indicate significant differences between the matrix predicted by the model and the matrix present in the data and are indicative of a poor fit. The CFI (Comparative Fit Index) compares the similarity between the covariance matrix predicted by the model and the matrix observed in the data. The Root Mean Square Error of Approximation (RMSEA) takes into account overall model complexity. CFI values should be greater than .90 whilst RMSEA values should ideally be lower than .10 (Bentler & Bonett, 1980; Byrne, 2001; Loehlin, 2004; Steiger, 1989). Finally, r^2 values show how much of the variance in each outcome variable is predicted by the hypothesised models. Table 3 presents the fit indices for both models.

The model based upon Direct and Indirect Perception predicts forty-six percent of the variance in *Victimful Criminality* and seventy-seven percent of the variance in *Teenage Conception Rates*. The Family Mediation model predicts forty-seven percent of the variance in *Victimful Criminality* and seventy-six percent of the variance in *Teenage Conception Rate*. Despite good r^2 values, fit statistics fail to meet the criteria of good models, with nearly all indicators failing to meet minimum thresholds. Fit statistics however show that the Direct and Indirect Perception model is significantly better than the Family Mediation model (X^2_{diff} = 188.88, df_{diff} = 6, p<.001). Nevertheless, both fall short of good fit to the data and the variance explained in the two dependent variables differs slightly between models. The models also differ in terms of significant predictor variables. In the Direct and Indirect Perception model, four variables significantly affect *Strategy*: *Father Absence,*

Education, Population Density and *Life Expectancy,* whilst all links between *Father Absence* and the remaining variables are significant (with the exception of *Number of Youths*). In the Family Mediation model, all predictor variables significantly predict *Father Absence* which in turn significantly affects the *Strategy* variable (again with the exception of *Number of Youths*). All significant variables across both models act in directions predicted by previous research.

Modelling direct and indirect effects on strategy development.

Both models, whilst conceptually plausible and showing patterns of relationships predicted in previous studies, fail to provide an adequate fit to the data. Despite this, many causal pathways between variables are significant and the r^2 values for both outcome variables are similar across models, suggesting that whilst the previous models are not compatible with the matrix present in the data, many causal pathways are important predictors of strategy-driven behaviours. An attempt was therefore made to re-specify the model based on Ellis et al. (as this presented a better fit) in order to establish a valid causal model.

The new structural model was created in the following manner. The sample was randomly split into two approximately equal subsamples. On the first subsample, an inclusive model with all direct and indirect effects was implemented; specifying all of the theoretical causal links between *Strategy, Father Absence* and the remaining predictor variables without constraints (consistent with the original Ellis et al. model). Furthermore, two additional modifications were made to this model supported by previous literature*. Population Density* and the *Number of Youths* are correlated with *Victimful Criminality,* but not with *Teenage Conception Rates* (see earlier discussion). Two direct links were therefore added linking *Victimful Criminality* to *Population Density* and *Number of Youths* in order to incorporate this theoretical connection. Using the same sample, a restricted model was then created by removing all causal pathways that were not significant. Links were only removed if

they fell below the p <.05 significance level. In this way, the exploratory model was guided by analysing the significance of causal links, rather than aiming to achieve a model with parsimonious fit statistics. The restricted model was then applied to the second subsample in an attempt to cross validate it and reduce potential Type I errors that may have emerged as part of the exploratory analysis. Finally, the model was applied to the whole sample for comparability with the original Direct and Indirect Perception, and Family Mediation models. In testing the models over multiple samples, it was hoped that a model could be created that was conceptually consistent with past research whilst being parsimonious with the covariance matrix of the data set.

Table 4 presents the fit statistics of the four models, whilst Figure 3 illustrates the standardised coefficients applied to the whole sample. Again, intercorrelations and residual error terms are omitted in the diagram. Table 4 shows that models omitting non-significant causal links between predictor and outcome variables, and adding the two additional links provide a more parsimonious fit to the data than the previous models. RMSEA and CFI values indicate patterns of results that are at least adequate in their fit to the data across all modified models. Although Chi-Square statistics are still significant, it should be noted that this indicator is sensitive to both sample size and strong inter-correlations between predictor variables (Kline 2005). Table 4 shows that the inclusive model is also an adequate fit to the data. However, many of the linkages were non-significant and the restricted model on the same sample produced a better fit, although not significantly so (X^2_{diff} =9.52, df_{diff} = 5, p>.05). Further testing of the inclusive model (by using the whole sample and the validation sample) also showed that the patterns of significant causal pathways and strengths of standardised beta weights differed across samples[5]. In the restricted model, across the two subsamples and the whole sample, the significance and the direction of the pathways illustrated in Figure 3 were more consistent (see appendix for standardised regression

[5] All statistics available on request

weights of each model). The modified model is therefore more robust across samples and remains consistent with the existing body of research in LHT. Furthermore, the modified model is a significantly better fit to the data than the model based on Direct and Indirect Perception (X^2_{diff} = 56.89, df_{diff} = 3, p<.001) and on Family Mediation (X^2_{diff} = 245.77, df_{diff} = 3, p<.001).

Figure 3 illustrates the significant causal linkages present in this model. Similar to the original Family Mediation model, all predictors except the *Number of Youths* significantly predict rates of *Father Absence*. Of these, *Unemployment* and *Youth Sex Ratio* have no direct links to anything else in the model and only increase rates of *Father Absence*. *Life expectancy* indirectly affects *Strategy* through its effect on *Father Absence* and this path is slightly weaker than its negative direct effect on *Strategy* (β = -.31 against β= -.34). *Education* shows a similar pattern of results (β = -.16 against β= -.44). The model suggests that family breakdown is more likely to occur in environments characterised by dense populations, high unemployment, low educational attainment, low partner availability for females (indexed by a significantly negative youth sex ratio) and poorer life expectancy.

Strategy itself is predicted by only three causal links. Strategy development is directly sensitive to levels of *Father Absence*, local rates of Life *Expectancy* and poor *Education* opportunities. Any effects of *Unemployment, Youth Sex Ratio* and *Population Density* on *Strategy* are indirect through their impact on *Father Absence*, making them more distal causes of strategy-driven behaviour.

Finally, the additional direct links between *Victimful Criminality* and *Number of Youths* and *Population Density* appear justified. *Number of Youths* is significant only for *Victimful Criminality* and not for *Teenage Conception Rate* (either directly or indirectly). *Population Density* shares the same positive link with *Victimful Criminality* whilst maintaining an indirect link via its effect on *Father*

Absence. This suggests that local population structures can affect rates of violence independent of other factors. It should be noted however that *Population Density* does have a significant effect *on Father Absence* and thus may indirectly affect pregnancy rates through its effect on this variable.

Discussion

The results confirm that violence and sexual precocity are moderately related to each other, supporting the existing literature that aggression and sexual behaviour rise and fall together within localities. Moderate to strong correlations were also found between predictor variables in this study and both outcome behaviours. Environments characterized by low life expectancies, poor educational prospects, rising unemployment, high levels of lone parenting, low youth sex ratios and dense populations are conducive to increasing rates of violence and sexually precocious activity.

SEM was used to determine whether a combination of direct and indirect perception of ecological threats (Ellis et al., 2009) was a better explanation of strategy development than indirect perception through the mediating effects of family breakdown (Belsky et al., 1991; Chisholm, 1999). Conceptually, the Family Mediation model supports existing literature, in that almost all predictor variables are significantly related to *Father Absence* which in turn is positively related to the hypothesised strategy variable responsible for the expression of the behaviours of interest in this study. The poor fit statistics however suggest that this model in its present form is underspecified and more complex effects are likely to be occurring between these variables. Although Direct and Indirect Perception is a significantly more parsimonious model, it too is a poor fit to the data matrix. Some of the results were surprising. Three important variables highlighted in the literature (*Unemployment, Number of Youths and Youth Sex Ratio*) were non-significant in their relationship with the hypothesised strategy variable. This suggests that the relationships between the predictor

variables are more complex than specified in this model and that the unique contributions of some predictors were masked by the effects of others.

The revised model more cogently highlights the importance of both direct and indirect perception in strategy development. Furthermore, despite achieving only an adequate statistical fit to the data, these effects are consistent across random sub-samples, allowing a measure of confidence in concluding that these effects are likely to be key in the development of any hypothesized strategy. The robustness of these effects is conceptually meaningful and thus as desirable as statistical parsimony. A brief discussion of this model's conceptual implications follows.

The modified model indicates that *Father Absence* can act as an important mediator between environment and behavioural expression. Family breakdown is associated with ecological factors indicative of scarce resources. Unemployment makes it harder for parents to provide for themselves and children, increasing familial stress levels and marital discord. Financial difficulty, economic instability and welfare dependency have all been shown to be common causes of intimate partner violence, divorce or union dissolution (Cunradi et al, 2000; Diem & Pizarro, 2010; Lewin, 2005; Lichter, Qian & Mellott, 2006; Weaver, Sanders, Campbell & Schnabel, 2009). An increase in population density (especially in an area of already limited resource) exacerbates these stress levels, as competition increases. A negative sex-ratio is also associated with family breakdown (Guttentag & Secord, 1983; Barber, 2000a, 2000b). When women are abundant, men find it easy to move from mate to mate, reducing parental investment in offspring, increasing the number of female-headed households and implicitly conveying to children that monogamy and paternal provision are not expectable. This complements the existing body of research on the long-term effects of father absence (Draper & Harpending, 1982; Belsky et al., 1991) and is consistent with Belsky et al's. proposal that family breakdown accelerates life history strategy. The effect of life expectancy on family stability is also important, thus supporting Chisholm's later additions to the model. External

cues to morbidity and mortality may be sufficiently stressful to disrupt the attachment process. These findings also generally support Chisholm's proposals that perceptions of mortality can be transmitted through the family unit to developing children, who then adopt faster LH strategies calibrated to suit local environments. The significant effect that *Father Absence* has on strategy is testimony to the clear mediating role that the familial environment has on levels of expression of socially undesirable behaviours.

The mediating role of *Father Absence* is only one of three effects on strategy development, with *Education* and *Life Expectancy* being equally significant. These results suggest that direct perception of environmental cues can foster the speed of individual life history trajectories. Education is a strong and direct determinant of strategy-based behaviour. As discussed earlier, education levels have been linked to both aggression and early pregnancy. Better education usually leads to better employment prospects, greater opportunities in the future and improved financial stability (Kaplan & Gangestad, 2004). From this perspective, education could be yet another scarce resource in the environment to which individuals are sensitive. In most western societies, children from as young as four years old spend many hours a day in an educational context. Child development studies have consistently shown that the educational context is likely to be of equal importance in child development and wellbeing as family, peer and neighbourhood environments (Brofenbrenner & Morris, 1998; Oberle, Schonert-Reichl & Zumbo, 2011; Theokas & Lerner, 2006; Youngblade & Curry, 2006). In educationally rich settings, children acquire skills that help them to maximise future reproductive and resource-accruing potential, and equip them for competition. Such individuals are less likely to resort to violence and less likely to advance their reproductive schedules. Individuals experiencing educational deprivation would be expected to show the opposite pattern. The effect of poor education on teenage conceptions may also be to reduce career opportunities and enhance the attractiveness of motherhood. Younger mothers are more likely to

have disliked school (Haldre, Rahu, Rahu & Karro, 2009), spent fewer years in school (Hofferth, Reid & Mott, 2002), or to have dropped out altogether (Heavey, Moysich, Hyland, Druschel & Sill, 2008). Several studies have noted that the desire for motherhood is stronger in young girls in deprived areas (Geronimus, 1992). Making rational (although possibly unconscious) decisions about accelerating reproductive schedules is critical to strategy development and is driven by making assays of one's life expectancy. Geronimus (1996) claimed that early-reproducing girls who "face not simply a shorter, but a far more uncertain lifespan.....may be planning for the kind of future they have every reason to expect" (Geronimus, 1996:346). Recent evidence on British girls (Nettle, Coall & Dickins, 2010) indicates that an intention to reproduce early was predictive of actual early reproduction, and that young women in poorer socioeconomic circumstances who desired early reproduction were more likely to have received lower levels of paternal investment. Teenage conception rates may also be affected by levels of education more directly through contraceptive education. Adolescent sexual decision-making can be based on insufficient or incorrect knowledge about sexual health and sexual practices (Gage, 1998; Kozinszky & Bártai, 2004; Paukku, Quan, Darney & Raine, 2003; Santelli, Morrow, Anderson & Duberstein Lindberg, 2006). It is impossible to determine from this data however whether desire for motherhood or lack of contraceptive knowledge plays the bigger part in increasing the rates of teenage conceptions and future work is required to separate their effects.

Life expectancy shows an interesting pattern of results, acting directly and indirectly on strategy development. It not only contributes to family breakdown; it can directly affect strategy development independent of family circumstance. Developing children may suffer from the stress caused by their parent's reaction to shortened life expectancy (Chisholm, 1999a), but they may also be making their own assays of their life expectancy through direct experience of their environment (Daly & Wilson, 1997; Ellis et al., 2009). Precisely how mortality assays are made is unclear. It may be

that individuals are directly sensitive to the frequency of critical environmental events such as natural disasters or famine. Pathogen sensitivity may also be important. Data show that levels of disease prevalence are related to violent behaviours toward partners and children (Thornhill & Fincher, 2011) and to measures of sociosexuality (Schaller & Murray, 2008). Evolved pathogen sensitivities may therefore play a part in mortality assays. Alternatively or additionally, individuals may be estimating the likely length of their own life by observing the people around them. An individual in an environment who seldom comes into contact with aged individuals may conclude (consciously or unconsciously) that they themselves cannot expect to live to old age (Mishra & Lalumière, 2008). Cues to environmental danger may also be important. Johns (2011) demonstrated that the odds of teenage motherhood increased in line with young women's belief that the environment in which they lived was dangerous. Similar results were found by Upchurch, Aneshensal, Sucoff and Levy-Storms (1999). This suggests that a construct such as the unpredictability schema suggested by Ross and Hill (2002) may be a psychological mechanism that catalogues such information from the environment. Perceptual mechanisms aside however, cues to mortality are clearly one of the most important determinants in shaping life history trajectories: studies which have asked respondents to estimate their likely age of death have found significant associations with life history variables (Burton, 1990; DuRant et al., 1997).

Violence, unlike early pregnancy, has two direct links that are independent of strategy: *Number of Youths* and *Population Density.* This link is the only significant effect of *Number of Youths* in the model. High numbers and density of youths in the locality (who are more violence prone than their elders, Daly & Wilson, 1985) present an increased likelihood and intensity of direct conspecific competition. Individuals are more likely to be involved in violent altercations simply by being amongst greater numbers of individuals with similar resource needs. This can create a violence spiral with proactive aggression being used to ward off attackers, as well as increased use of defensive

aggression. It is therefore feasible that some facets of the environment represent a form of “local enabling circumstance" that may inhibit or exacerbate the expression of some life history traits but not others. Future research will hopefully highlight which other facets of the environment (if any) have similar effects on behaviour.

The revised model also clearly highlights the importance of the potentially additive effects of ecological variables. *Life Expectancy, Education* and *Population Density* each affect multiple levels of the model. This suggests that these variables are especially important due to their cumulative effects. Belsky et al. (2011) demonstrated a similar additive effect in a longitudinal study of 1,364 families. Indicators of environmental unpredictability (such as parental transition, household movement and parental employment transition) were significantly related (both directly and indirectly) to early and late symptoms of maternal depression, maternal sensitivity (a proxy for attachment) and sexual precocity of children aged 15. However environmental harshness (indexed by an income to needs ratio) had no significant direct effect upon sexual precocity. The impact of some ecological factors on LH strategies can therefore be enhanced by their impact on multiple causal pathways.

Limitations

Several limitations of the study should be noted. Firstly, Female Lone Parents is an imperfect and incomplete measure of the family environment and *Father Absence*. At the level of local authority data, only structural variables are recorded (divorce rates, household composition, etc). This variable does not take into account the addition of subsequent partners to the family unit or possible investment from other sources. It could be argued that this variable in itself is an indicator of strategy selection that might be transmitted to offspring genetically or culturally, as well as acting as a proximal environmental cue. In future research, in addition to structural variables, measures of

childhood attachment would provide meaningful psychological indicators of family climate and stability.

Recent research suggests other variables that might usefully be incorporated in future studies. Nettle et al. (2010) demonstrated that low birth weight uniquely contributed to the prediction of early reproduction, alongside paternal investment and indicators of socioeconomic status. Additionally, research also demonstrates that most behavioural and psychological traits linked with LHT show degrees of heritability (Bouchard, 2004), especially early maturation (Rowe, 2002). It should also be acknowledged that the strong correlations between variables of interest in this study could be a result of covariation of genotypes within communities, as well as shared environmental factors. It is important that future work incorporates biological and ecological factors to fully encompass the developmental environment of individuals.

This study looked at the environment's effect on behaviours at a macro level. Although certainly informative and supportive of previous works in LHT, it should be the aim of further studies to establish if these same relationships exist at the level of the individual. Indeed, by examining the micro level, many of the limitations of this study could be more readily addressed.

To conclude, the results of this study suggest that violent crime and early reproduction represent two behaviours characteristic of an underlying life history continuum and that an individual’s position on this continuum may be contingent both directly and indirectly on perceptions of ecological stressors. The family unit as a source of stress is doubtlessly important, but first-hand experience of the environment itself plays a pivotal role in developing strategy based behaviours.

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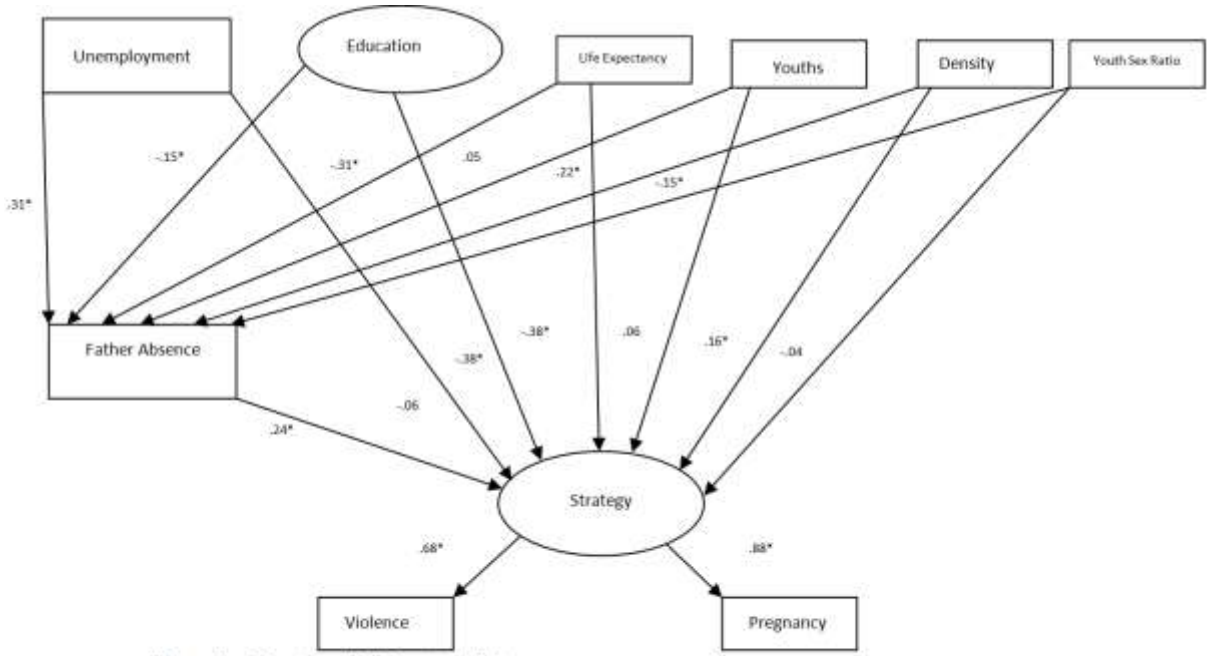

Figure 1. Direct and Indirect model

* p<.001

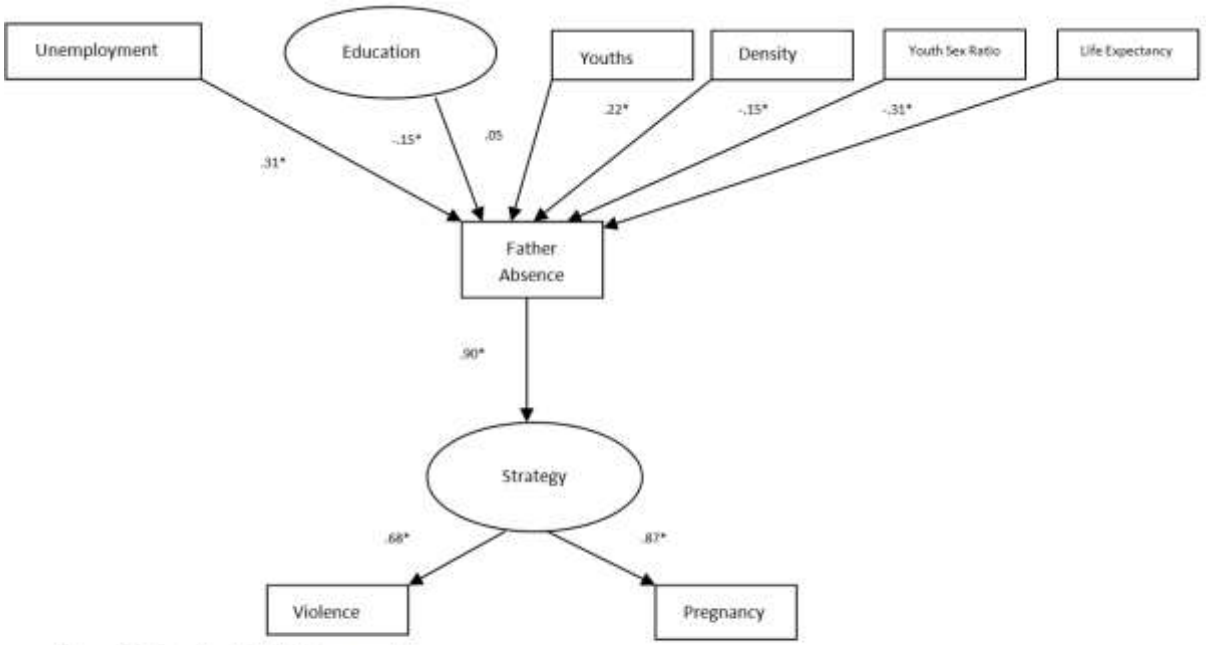

Figure 2. Family Mediation model

* p<.001

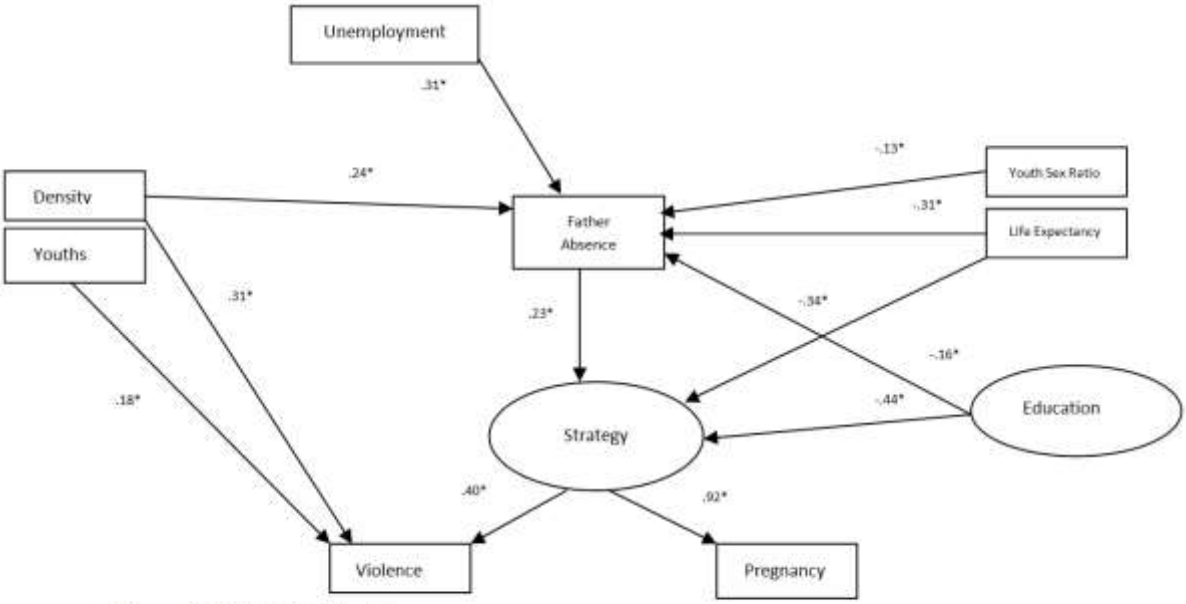

Figure 3. Modified Model

* p<.001

Table 1: Descriptive Statistics (N=339)

Variable	Mean	Standard Deviation
Violence	24.44	13.15
Pregnancy	38.93	13.04
Life Expectancy	63.64	3.21
Education*	.00*	1.00*
Unemployment	16.26	9.31
Father Absence	58.45	17.97
Population Density	11.04	12.72
Number of Youths	175.12	30.34
Youth Sex ratio	100.47	4.92

*Standardized regression score used for the purposes of correlation analysis

Table 2: Table of Correlations (N=339)

	Violence	Pregnancy	Life Expectancy	Education	Unemployment	Father Absence	Population Density	Number of Youths
Pregnancy	.59**							
Life Expectancy	-.50**	-.79**						
Education	-.56**	-.78**	.69**					
Unemployment	.52**	.68**	-.79**	-.62**				
Father Absence	.61**	.78**	-.79**	-.69**	.79**			
Population Density	.62**	.49**	-.33**	-.48**	.42**	.55**		
Number of Youths	.55**	.42**	-.29**	-.46**	.39**	.43**	.65**	
Youth Sex Ratio	.01	-.26**	.25**	.14**	-.22**	-.30**	.01	.23*

**p<.01 level, *p<.05

Table 3: Model Comparisons.

Sample	n	VC r^2	TP r^2	X^2	DF	X^2/DF	P	RMSEA	CFI
Family Mediation Model	339	.47	.76	333.22	28	11.90	**	.18	.92
Direct/Indirect Model	339	.46	.77	144.34	22	6.56	**	.13	.97

Note, *p<.05, **p<.01, VC r2 (Victimful Criminality r2 value), TP r2 (Teenage Pregnancy r2 value)

Table 4: Modified Model Comparisons

Sample	n	VC r^2	TP r^2	X^2	DF	X^2/DF	P	RMSEA	CFI
Inclusive Model	169	.54	.85	52.86	20	2.64	**	.10	.98
Restricted Model	169	.54	.84	62.38	25	2.50	**	.09	.98
Validated Model	170	.55	.85	45.83	25	1.83	*	.07	.99
Whole Sample	339	.54	.84	87.45	25	3.50	**	.09	.98

Note, *p<.05, **p<.01, VC r2 (Victimful Criminality r2 value), TP r2 (Teenage Pregnancy r2 value)

Appendix 1: Standardised regression weights for the modified model over three samples

			Restricted (N=169)	Validated (N=170)	Whole (N=339)
Father Absence	<	Education	-0.14*	-0.19**	-.16**
Father Absence	<	Population Density	0.20**	0.28**	.24**
Father Absence	<	Unemployment	0.39**	0.22**	.31**
Father Absence	<	Youth Sex Ratio	-0.10*	-0.17**	-.13**
Father Absence	<	Life Expectancy	-0.30**	-0.31**	-.31**
Strategy	<	Father Absence	0.24**	0.30**	.28**
Strategy	<	Education	-0.45**	-0.44**	-.44**
Strategy	<	Life Expectancy	-0.37**	-0.31**	-.34**
Conception Rate	<	Strategy	0.92**	0.92**	.92**
Violence	<	Strategy	0.41**	0.40**	.40**
Violence	<	Population Density	0.28**	0.33**	.31**
Violence	<	Youths	0.21*	0.16*	.18**

Note,*p<.05, **p<.001