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Are the early childhood antecedents of men’s external locus of control similar to those of their female partners? [version 1; referees: 2 approved]

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Abstract

Background: The concept of locus of control of reinforcement was introduced by Julian Rotter and has been the focus of intense research for nearly half a century. Surprisingly little research has been directed at clarifying antecedents of locus of control (LOC) orientations in adult men apart from a few small studies. We previously identified a number of independent antecedents associated with women’s LOC, including features of their parents and early childhood. This raised the question as to whether these factors were also associated with the development of LOC in men.

Methods: To identify antecedents of LOC orientations in a representative population of women we previously analysed information concerning characteristics of their parents and their own childhood experiences using pregnant women taking part in the Avon Longitudinal Study of Parents and Children (ALSPAC). Here we use the same design to determine whether their male partners have similar antecedents of LOC orientation. As previously, we use a hypothesis-free exposome technique using all available information on the parents and childhood of the individuals.

Results: We show that men had many of the same antecedent characteristics as the women – in particular, their mother’s year of birth and father’s social group, being exposed to cigarette smoke prenatally, starting to smoke regularly before the age of 11, and having a friend die were all associated with being external. Associations of internality common to both were warm maternal care, being breast fed, being born in an area other than that where they currently live, attending boarding school and having a parent admitted to hospital.

Conclusions: In general, the antecedents of male external and internal personalities have many similarities to those of women, thus providing some features to inform the possible theoretical background as to how LOC might develop over time.

Keywords

ALSPAC, Locus of Control, men, childhood, prenatal smoking, parental influences, breast feeding, maternal warmth
Introduction

Locus of control (LOC) refers to individuals’ generalized expectancy regarding the connection between their behavior and its consequences in a problem solving context. Those who fail to see a connection between what they do and what happens to them and instead view what happens to them as the result of luck, fate, chance, or powerful others are seen as externally controlled (ELOC). Conversely those who tend to perceive a connection between their efforts and what happens are called internally controlled (ILOC).

Because of the hundred plus definitions of “locus of control” sprinkled throughout the research literature it is important that each study clearly state and define which LOC concept and measure are being used (Infurna & Reich, 2016; Skinner, 1996). Peterson & Stunkard (1992) noted the possible problems that could result from using cognates, like efficacy and perceived control (Bandura, 1986; Infurna & Mayer, 2015; Lachman & Weaver, 1998) or attribution (Peterson & Seligman, 1984; Seligman, 1975) interchangeably with locus of control of reinforcement as described by Rotter (Rotter, 1954; Rotter, 1966). He defined locus of control of reinforcement as being a generalized expectancy within his social learning theory (Rotter, 1954; Rotter, 1966) noting, among other things, that LOC was not a trait. In contrast to traits that characterize people’s personality and operate similarly across situations, Rotter pointed out that a generalized expectancy like LOC should have its greatest impact in situations that are novel, ambiguous or transitory.

Peterson & Stunkard (1992) described how LOC differed from self-efficacy and attribution as follows: “Locus of control refers to one’s generalized expectancies about the origin of rewards and punishment in the world; self-efficacy refers to one’s belief about whether a given behaviour can be enacted, and explanatory style refers to one’s habitual way of explaining the causes of events”.

Although each cognate has generated its own significant and extensive set of findings, it is also true that the findings often overlap one another. That could suggest that they simply are different ways of referring to the same cognate and blurs the reality that the cognates actually can trace their origins to different theoretical perspectives and are measuring something different from one another. In the present study the cognate we are using is the one called locus of control of reinforcement (LOC) that was introduced by Rotter (1966).

Over the past 50 years LOC, as defined by Rotter, has proven to be one of the most frequently studied variables in personality psychology and has been found to be significantly related to an increasing number of important and significant aspects of human life including personality characteristics, social adjustment, academic achievement, health, and business success (Lefcourt, 1982, Lefcourt, 1983; Nowicki, 2016a; Nowicki & Duke, 2016; Rotter, 1966; Rotter, 1975, Rotter, 1990).

Rotter offered clear theoretical assumptions for the development of LOC expectancies. For him basic LOC orientations are initially learned through children’s experiences with their parents. To facilitate the learning of internal LOC expectancies Rotter suggested that parents: (1) consistently reinforce children’s behavior contingently; (2) allow children more autonomy and independence; and (3) create a nurturing safe environment within which children can discover the connections between how they behave and the consequences.

Carton & Nowicki (1994) reviewed the extant literature to evaluate whether these theorized antecedents of LOC were supported. They concluded that there was empirical support for four parental factors in the development of children’s LOC: (a) The degree of control parents exhibited over their children: more control, higher externality, less control more internality. (b) Externality was associated with a greater degree of life stress produced by father absence due to divorce or death and/or by intense marital discord. (c) Children’s internality was associated with parents who were perceived by children or by themselves as warm, emotionally supportive and nurturing. (d) Internality was associated with parents who rewarded and punished consistently and contingently. However, Carton & Nowicki (1994) also noted that these conclusions were based on data gathered from research studies that used relatively few participants from homogeneous populations of participants, most often children.

Not surprisingly, most studies that have examined “antecedents” of LOC have been focused on children, and the factors associated with their being more internally or externally controlled. Fewer have been interested in identifying child or adolescent precursors of adult LOC, and fewer still have focused on adult males.

Data concerning possible antecedents of LOC in adults would be helpful in obtaining a better understanding of the developmental processes that are associated with internality versus externality throughout the lifespan. With such information, more effective intervention programs could be developed to change or maintain LOC in children and adults.

Data previously analyzed (Golding et al., 2017a; Golding et al., 2017b) were obtained from pregnant women who were taking part in the Avon Longitudinal Study of Parents and Children (ALSPAC) to determine features of their own parents and their childhood associated with their LOC orientations. Externality was defined as an LOC score that was greater and internality defined as equal to or less than the median score on the Anglicized Nowicki-Strickland Internal-External control scale (ANSIE) (Nowicki, 2016b; Nowicki & Duke, 1974). This measure was designed to be consistent with Rotter’s (1966) definition of LOC and the test he developed to measure it, but with an easier reading level. Detailed analysis showed that the likelihood of women being external increased with certain details of their parents’ demographic background, features of early and mid-childhood, traumatic events and their social environment (Golding et al., 2017a; Golding et al., 2017b).

While helpful, these studies are only the first steps in describing the possible events and experiences associated with becoming
internal or external in a representative population of adults. In 
the present study, we took the next step by examining anteced-
ents of LOC in a representative population of male participants to 
see how similar they were to those identified among their female 
counterparts. The empirical literature does not offer us much 
aid in making predictions about gender differences in LOC 
antecedents so no such predictions were made. Generally then, 
Rotter suggests that the degree of parental consistency and 
nurturing plays an important role in determining LOC for both 
men and women. Schneewind (1997) offers a concise summary of 
previous parental antecedents that guides our expectation for 
what we find in the present study.

“Parents providing a stimulating family environment, being 
consistently and contingently responsive to their children’s 
behaviour, emphasizing early independence training, engaging 
autonomy granting, and less intrusive interactions, using less 
hostile and more inductive disciplinary techniques and relating to 
the child in a warm and emotionally supportive way, tend to have 
children with a more internal control orientation. Conversely, 
parents who provide less stimulation, who are less responsive 
and more authoritarian, intrusive, overprotective, rejecting, or 
neglectful are more likely to have children with an external 
control orientation.”

Material and methods

The ALSPAC study

This pre-birth cohort was designed to determine the environ-
mental and genetic factors that are associated with health and 
development of the study offspring and their parents (Boyd et al., 
2013; Golding et al., 2001). Enrolment in the study was 
voluntary, but a number of tactics were employed to invite 
pregnant women with an expected date of delivery between 
April 1991 and December 1992 to take part. Strategies included 
encouragement through the local media, general practitioners, 
midwives, health services and obstetric hospitals; women then 
contacted the study center for further information, and they were 
then sent a series of questionnaires to be completed in their own 
homes. Uniquely among the major UK cohort studies at that 
time, it was decided to include the fathers of the children. 
This produced some discussion among the ALSPAC advisory 
committees, especially as a large proportion of the pregnant 
women were not married. It was therefore decided to invite 
the study women to involve their partners if they so wished. To this 
end questionnaires were sent to her to pass to her partner if she 
was happy for him to take part. This strategy was approved by 
the ALSPAC Ethics and Law Committee (ALEC) (Birmingham, 
2018). Consequently there was no immediate way in which the 
study administrators knew the identity of the study fathers. 
Given the uncertainty of this approach, it is striking how many of 
their partners took part during the pregnancy (10,000 compared 
with 13,867 pregnant women (Fraser et al., 2013). These are the 
men studied in this paper. This method by which the men were 
involved in the study was approved by a number of ethics 
committees, and the return of self-completion questionnaires 
continues to be considered acceptable as ‘implied consent’ 
(Birmingham, 2018).

Because it was thought that features of the birth of the baby, and 
any difficulties involved, might alter the parents’ responses in 
regard to their attitudes and behaviors, there was a concerted 
effort before the end of the pregnancy to obtain details of their 
personalities, moods and attitudes, including a measure of their 
LOC. For full details of all the data collected see the study 
website. Ethical approval for the study was obtained from the 
ALSPAC Ethics and Law Committee and the Local Research 
Ethics Committees (Birmingham, 2018).

For this project we concentrate on the data collected from 
questionnaires completed before the birth of the study child. The 
pregnant women were sent four questionnaires for themselves, and 
two for their partners during the pregnancy. The LOC scale was 
included in each parents’ set of questionnaires.

The outcome measure

The LOC measure used in the present study is a shortened version 
of the adult version of the Nowicki-Strickland Internal-External 
locus of control scale (ANSIE) which comprises 40 items in 
a yes/no format to assess perceived control (Nowicki & Duke, 
1974). This was chosen over other scales more specifically related 
to perceived control over health, as it was considered that this 
more generalized scale would relate to other factors in addition to 
health outcomes. Construct validity for the scale has been found 
in the results of over a thousand studies (Nowicki, 2016a). The 
version used in the present study comprises 12 of the original 
40 items which were chosen after factor analysis of the ANSIE 
administered as a pilot to 135 mothers in the USA. From the 
responses LOC scores were derived for the men as well as for 
the women, the higher the score the more external the LOC. The 
scores ranged from 0 to 12.

The frequency for the women was roughly normally distrib-
uted with a median of 4, whereas for the men the distribution 
was less obviously Gaussian, with a median of 3. For this study 
external locus of control (ELOC) was defined as having a score 
greater than the median. This cut-off identified 46.6% of the men 
as externally controlled.

The possible antecedent variables considered

In this paper we consider five different groups of variables 
pertaining to: (a) the demographic background of the parents 
of the men; (b) their birth and early childhood (< 6 years); (c) 
features of their mid-childhood (6–11 years) and adolescence 
(12–15 years); (d) traumatic events occurring during childhood; 
and (e) their social environment during childhood. The details 
of the variables are described below. The research questions 
concern the extent to which different aspects of the back-
grounds of their parents and childhoods are associated with the 
ELOC of the men, and whether these factors are similar to those 
associated with the ELOC of the women as described elsewhere 
(Golding, et al., 2017a; Golding, et al., 2017b).

a. Parental education level achieved

Information was obtained on all the qualifications of the man’s 
mother and father. From the information obtained a 5-point
education scale has been obtained for each, with the following categories: No qualifications; Not higher than CSE or GCSE (D, E, F or G); O-Level or equivalent; A-level or equivalent, such as Teaching or Nursing qualification; University degree. This scale was similar to that derived for the Child Health & Education Study (Osborn et al., 1984). For the present study, these qualifications have been categorized into two groups: O-level and above; lower than O-level.

b. Occupations of parents
Data were obtained concerning the employment situation of each of the parents of the men with details of their normal job, occupation, trade or profession with the type of industry or service given. These occupations were classified using the Standard Occupational Classification (SOC) codes published by the Employment Department Group Office of Population Censuses and Surveys of Great Britain (Office of Population Censuses & Surveys, 1990). The SOC divides occupations into groups based upon the qualifications and skills necessary to perform each job optimally.

c. Ethnic origins
The ethnic origins of the man and each of his parents were obtained using the format asked in the 1991 United Kingdom Census. This categorizes individuals as White, Black/Caribbean, Black/African, Black/Other, Indian, Pakistani, Bangladeshi, Chinese, Other Specified. In the Avon area at this time, only about 6% of the population comprised ethnic minorities.

d. Home stability
The man was asked to rate the stability and predictability of each of his parent’s behavior during his childhood. The question was: ‘was your parent’s behavior stable and predictable to you as a child?’ with possible answers: always, mostly, rarely, never. The data were obtained for his mother, father, mother figure, father figure, and a ‘home stability’ variable derived from the answers. These questions were created by Karen Thorpe specifically for ALSPAC.

e. Childhood happiness
Also developed by Karen Thorpe, the questions were worded: ‘Looking back would you call your childhood happy?’ For each of the ages 0–5, 6–11, 12–15 the man was given options ‘yes very happy’, ‘yes moderately happy’, ‘not really happy’, ‘no, quite unhappy’, ‘no, very unhappy’. After these questions there was space for any comments he might like to add. From the answers to the three questions, a variable concerning childhood happiness was derived to distinguish those who were very happy throughout from those who were not.

f. Other data relevant to the three age periods - his early childhood, mid-childhood and adolescence
Information was obtained on specific persons resident in the household during the three time periods viz. mother, father, step-father, step-mother, step-brother, step-sister, mother’s partner.

g. Childhood life events
This comprised a set of 30 specific questions administered in mid pregnancy. Childhood was specified as being <17 years. The items were devised by the ALSPAC Study Team based on the earlier work of Coddington (1972). The items included four on deaths to parent(s), relative(s), sibling(s) and friend(s); three on serious illness to the participant as well as to a parent and sibling; three on experiencing a serious accident (to parent, participant, sibling); three on hospitalization (to parent, participant and sibling); three concerning abuse to the participant (physical, sexual and emotional); seven relating to parents (separated, divorced, had serious arguments, remarried, imprisoned, mentally ill, family became poorer); and seven to the participant themselves (discovered that she/he was adopted, failed an important exam, moved to a new district, in trouble with the police, expelled or suspended from school, became physically deformed, girlfriend became pregnant. The study used the responses as to whether each of the different life events had occurred or not.

h. Other information relating to childhood
Data collected included the number of schools attended before the age of 16, the number of younger and older siblings, and whether he was a twin or not, as well as whether he had been adopted, taken into care, or had experienced a number of other events during his childhood. Respondents reported whether their parents had divorced before their 16th birthday and the age at which the divorce occurred. Respondents also reported whether their biological mother or father died before their 16th birthday and their (i.e. the respondent’s) age when the death occurred.

i. Relationship with his mother.
His relationship with his own mother (or mother figure) was elicited using a 22-item set of questions modified from the original Parent-Bonding Instrument (PBI). Respondents reported the quality of their relationship with their mother in childhood on two scales: the care and overprotectiveness subscales (Parker et al., 1979). Previous research supports the validity and reliability of these scales, particularly their association with depression and the validity of retrospective reports (Parker, 1981).

The original Parent Bonding Instrument (Parker et al., 1979) had been adapted by Gamsa (1987) to reword the statements that had produced double negatives in the original. During the course of piloting it became obvious that our parents were unhappy with the original options for responses (very like, moderately like, moderately unlike, very unlike) and they have been changed to: ‘never’, ‘sometimes’, ‘usually’. In addition, three questions were omitted since they were almost identical to other questions in the scale and caused considerable annoyance to participants. The introduction to the 22 statements read as follows: ‘we would like to know how you and your mother got on when you were a child. This will probably have varied over your childhood and in different situations but we would like a general impression. Please tick the box to indicate how you mostly remember your mother in the first 16 years’.
Two scores were derived from these 22 questions: a ‘maternal care’ score, and an ‘overprotective’ score. Internal consistencies in this sample were 0.73 and 0.70 for care and over-protectiveness, respectively (O’Connor et al., 1999). This instrument has been used with the ALSPAC data to show that the link between divorce of one’s parents during childhood and adult depression and/or divorce was partly mediated through the quality of parent-child relations (O’Connor et al., 1999).

Statistical analyses

The following exposome analyses were undertaken using STATA version 14 for the ELOC of the study men in the same way as for the study women – i.e. (i) the unadjusted associations with ELOC were calculated for each of the groups of variables; (ii) the variables with unadjusted P value < 0.05 were selected and offered to a backward logistic regression analysis for each group; (iii) the results for each group were considered in regard to the numbers of individuals left in each regression and variables were either dropped or recoded to increase the numbers available in the regression where feasible; (iv) once these intra-domain regressions were finalized, the groups were combined for inter-group analyses in a similar way to our earlier publications (Golding et al., 2017a; Golding et al., 2017b). Comparison of goodness-of-fit (GOF) between the analyses used 100 times the pseudo-R² statistic, the higher the value the better the fit.

It should be noted that this is a hypothesis generating study. Consequently to avoid type 2 error, no account is taken of the number of tests undertaken.

Results

The demographic backgrounds of the individuals in this study are shown in Table S1 (Supplementary File 1). The LOC score was available for 8645 men, and had a mode and median of 3.

Relationships with characteristics of his parents

Similar to the study of LOC among the women (Golding et al., 2017a; Golding et al., 2017b), we considered several different variables describing demographic features of each of the men’s parents; the percentage of men who had an ELOC are depicted in Table 1. This shows that the proportion of the men with ELOC varied with their mother’s year of birth, such that the more recent the mother’s birth the higher the proportion (P<0.0001). The mothers with higher educational qualifications had a substantially lower proportion of sons with ELOC (P<0.0001), but the men were at greater risk of externality if their mothers were aged less than 25 when they were born, if their mothers were smokers, particularly if they had smoked when pregnant with them, or if their mothers had a routine type of occupation (all P<0.0001). There was only a marginal association with the mother’s ethnic background, the 4% of those men with a non-white mother having a lower rate of ELOC (P=0.042).

Logistic regression showed that the major features of his mother that were independently associated with her son’s increased risk of ELOC were poor maternal education, her year of birth (the more recently she had been born the higher the risk), her social group (the less professional the higher the risk) and whether she smoked when pregnant (Table S2; Supplementary File 1). In the presence of these factors, the age of the mother at the birth of her son, and her overall smoking history failed to enter. However, due to the relatively small number of mothers for whom the social group had been recorded, the total numbers in this regression (Model A) were only 2258 with a GOF of 4.2. Omitting the social group variable resulted in an increase in numbers to 4067 but a slight reduction in GOF to 3.8. Because of the increase in numbers, and relatively small reduction in the GOF, we have retained this version in the rest of this paper (Table S2; Supplementary File 1). Thus model (B) comprised his mother’s education level, her year of birth and whether she smoked when pregnant with him (all P<0.0001).

For his father, unadjusted relationships showed significant associations with his father’s year of birth, his father’s education level, whether he was aged <25 at the birth of his son, whether he had a history of smoking as well as his social group (all P<0.0001). Intra-domain logistic regression indicated that the major independent factors predictive of ELOC comprised his father’s year of birth, level of education, history of smoking and his social group, the more routine the occupation the more likely the son to have an ELOC. The father’s age was attenuated by other factors in this model, which included 3578 observations and had a GOF of 4.4 (Table S3; Supplementary File 1).

Combining the information from both parents resulted in a model with just five variables: the year of birth of each parent, his mother’s education, his father’s social group and whether his mother had smoked when pregnant with his son. In the presence of these variables the father’s history of smoking and his education level did not enter (Table 2).

Relationships with facets of his early childhood

Of the 16 variables recorded relating to his early childhood (<6 years), eight were statistically significantly related to ELOC before adjustment (Table 3): they comprised an increase in risk if step-father, father’s partner or step-sibling was present in the home, whether he had two or more older siblings, whether his parents had divorced or separated during this period and whether he described this period of his life as unhappy. Conversely, if he had been breast fed, or was born to parents residing outside the Avon area, he was more likely to have an internal LOC.

For the logistic regression we omitted the variable concerning presence of father’s partner as there were only small numbers involved. Backwards stepwise logistic regression using the remaining seven factors showed that only three remained (being born outside Avon, being breast fed and the number of older siblings, the latter being of borderline significance (P = 0.034; Table S4, Model A; Supplementary File 1). However the numbers left in this model were small (2767), so in a further exercise we dropped the older siblings variable (which was responsible for the decrease in numbers) and reanalyzed. This resulted in larger numbers in the model (4056) and an increase in the GOF (from 3.83 to 4.72). This analysis also indicated that the
Table 1. Proportion of men with external locus of control (ELOC) and demographic features of their mothers and fathers.

| Features of parents | MOTHERS | | | FATHERS | | |
|---------------------|---------|-------------------------------|-----------------|---------|-------------------------------|-----------------|
|                     | % (n) ELOC | OR [95% CI] | P     | % (n) ELOC | OR [95% CI] | P     |
| Year of Birth       |           |               |       |           |               |       |
| N=5341              | <0.0001   |                |       | N= 5127   | <0.0001       |       |
| Pre–1920            | 35.0% (307) | 0.85 [0.71, 1.02] | 0.96 [0.79, 1.18] | 37.0% (241) | 1.00 [0.82, 1.21] | <0.0001 |
| 1920–1924          | 37.3% (335) | 0.94 [0.78, 1.12] | 0.96 [0.81, 1.15] | 37.1% (375) | 0.96 [0.81, 1.15] | <0.0001 |
| 1930–1934          | 38.8% (454) | 1.00 Ref | 1.00 Ref | 37.9% (412) | 1.00 Ref | <0.0001 |
| 1935–1939          | 42.6% (455) | 1.17 [0.99, 1.38] | 1.47 [1.23, 1.76] | 42.6% (428) | 1.47 [1.23, 1.76] | <0.0001 |
| 1940–1944          | 51.6% (444) | 1.37 [1.20, 1.57] | 1.81 [1.47, 2.22] | 52.5% (412) | 1.81 [1.47, 2.22] | <0.0001 |
| Post 1944          | 62.7% (294) | 2.65 [2.12, 3.10] | 3.08 [2.28, 4.16] | 65.3% (147) | 3.08 [2.28, 4.16] | <0.0001 |
| Ethnic Group       |           |               |       |           |               |       |
| N=7865              | 0.042     |                |       | N=7844    | 0.273          |       |
| White              | 46.4% (3576) | 1.00 Ref | 1.00 Ref | 46.3% (3544) | 1.00 Ref | <0.0001 |
| Non-white          | 38.4% (63)  | 0.72 [0.52, 0.99] | 0.85 [0.64, 1.13] | 42.3% (83)  | 0.85 [0.64, 1.13] | <0.0001 |
| Education Level    |           |               |       |           |               |       |
| N=6022             | <0.0001   |                |       | N=6045    | <0.0001       |       |
| ≥O-Level           | 32.6% (658) | 0.51 [0.46, 0.58] | 0.52 [0.47, 0.58] | 33.2% (765) | 0.52 [0.47, 0.58] | <0.0001 |
| <O-Level           | 48.5% (1943) | 1.00 Ref | 1.00 Ref | 48.7% (1824) | 1.00 Ref | <0.0001 |
| Age at Birth of Subject |     |           |       |           |               |       |
| N=6670             | <0.0001   |                |       | N=6366    | <0.0001       |       |
| <25                | 49.5% (1152) | 1.43 [1.29, 1.59] | 1.37 [1.20, 1.57] | 49.6% (1824) | 1.37 [1.20, 1.57] | <0.0001 |
| 25–34              | 40.7% (1405) | 1.00 Ref | 1.00 Ref | 41.8% (1487) | 1.00 Ref | <0.0001 |
| 35–39              | 40.9% (364)  | 1.01 [0.87, 1.18] | 0.92 [0.79, 1.06] | 39.7% (369)  | 0.92 [0.79, 1.06] | <0.0001 |
| 40+                |           |               |       |           |               |       |
| Ever Smoked        | N=7829    | <0.0001       |       | N=7274    | <0.0001       |       |
| Yes                | 49.8% (2206) | 1.41 [1.29, 1.55] | 1.34 [1.20, 1.50] | 47.5% (2692) | 1.34 [1.20, 1.50] | <0.0001 |
| No                 | 41.3% (1404) | 1.00 Ref | 1.00 Ref | 40.3% (648)  | 1.00 Ref | <0.0001 |
| Smoked Prenatally  | N=7797    | <0.0001       |       | -         | -              |       |
| Yes                | 52.6% (1694) | 1.56 [1.42, 1.71] |             |             |             |       |
| No                 | 47.4% (1015) | 1.34 [1.20, 1.50] |             |             |             |       |
| Social Group       | N=4155    | <0.0001       |       | N=7173    | <0.0001       |       |
| Higher managerial  | 31.0% (35)  | 0.86 [0.56, 1.31] | 0.76 [0.64, 0.89] | 28.8% (290)  | 0.76 [0.64, 0.89] | <0.0001 |
| Lower managerial   | 34.4% (277) | 1.00 Ref | 1.00 Ref | 34.8% (630)  | 1.00 Ref | <0.0001 |
| Intermediate       | 38.4% (385) | 1.19 [0.98, 1.44] | 1.41 [1.12, 1.99] | 43.1% (143)  | 1.41 [1.12, 1.99] | <0.0001 |
| Small employers    | 36.1% (79)   | 1.08 [0.79, 1.47] | 1.99 [1.68, 2.36] | 51.6% (393)  | 1.99 [1.68, 2.36] | <0.0001 |
| Lower supervisory  | 51.2% (43)   | 2.00 [1.27, 3.14] | 1.85 [1.63, 2.11] | 49.8% (1015) | 1.85 [1.63, 2.11] | <0.0001 |
| Semi-routine       | 49.3% (544) | 1.85 [1.54, 2.23] | 2.15 [1.75, 2.64] | 53.4% (248)  | 2.15 [1.75, 2.64] | <0.0001 |
| Routine            | 58.9% (487) | 2.73 [2.23, 3.34] | 3.02 [2.53, 3.60] | 61.8% (470)  | 3.02 [2.53, 3.60] | <0.0001 |

OR indicates the unadjusted odds of their son having an ELOC orientation; in brackets are the numbers of men with ELOC.

Table 2. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his parents.

| Variable                                      | N   | P       | OR [95% CI] |
|-----------------------------------------------|-----|---------|-------------|
| Mother’s education ≥ O-Level                  | 3652| <0.001 | 0.75 [0.64, 0.87] |
| Mother’s year of birth                        | 3652| <0.001 | 1.27 [1.10, 1.47] |
| Mother smoked when pregnant                  | 3652| <0.001 | 1.41 [1.22, 1.62] |
| Father’s year of birth                        | 3652| 0.032  | 1.15 [1.01, 1.31] |
| Father’s social group                         | 3652| <0.001 | 1.17 [1.12, 1.21] |

Total N=3652, Goodness of fit measure =4.73

*pre 1925; 1925–1939, 1940–1944; post 19; *pre 1935; 1935–1939, 1940–1944; post 1944. *the seven categories
### Table 3. Associations between features of early childhood (≤5yrs) and external locus of control (ELOC).

| Features of his childhood | % (n) | ELOC | OR [95% CI] | P     |
|---------------------------|-------|------|-------------|-------|
| **In First Year**         |       |      |             |       |
| Ethnic Background         | 8292  |      |             | 0.239 |
| White                     | 46.1% (3731) | 0.84 | [0.63, 1.12] |       |
| Non-white                 | 41.8% (82) | 0.84 | [0.63, 1.12] |       |
| Place of Birth N=7856     |       |      |             | <0.0001|
| Avon                      | 56.3% (2616) | 1.00 | Ref         |       |
| Rest of England           | 31.8% (776) | 0.36 | [0.33, 0.40] |       |
| Rest of World             | 36.7% (282) | 0.38 | [0.35, 0.42] |       |
| Was Adopted               | 8768  |      |             | 0.705 |
| Yes                       | 48.5% (49) | 1.08 | [0.73, 1.60] |       |
| No                        | 46.6% (4041) | 1.00 | Ref         |       |
| Was Breastfed             | 5027  |      |             | <0.0001|
| Yes                       | 40.2% (1351) | 0.62 | [0.55, 0.70] |       |
| No                        | 52.0% (867) | 1.00 | Ref         |       |
| No. of Older Siblings     | 4850  |      |             | <0.0001|
| 0                         | 36.6% (704) | 1.00 | Ref         |       |
| 1                         | 39.7% (619) | 1.14 | [1.00, 1.31] |       |
| 2                         | 44.5% (354) | 1.39 | [1.17, 1.64] |       |
| 3+                        | 50.6% (289) | 1.78 | [1.47, 2.15] |       |
| **In First 5 Years**      |       |      |             |       |
| Mother Present in Home    | 8768  |      |             | 0.905 |
| Yes                       | 46.6% (3819) | 0.99 | [0.84, 1.17] |       |
| No                        | 46.9% (271) | 1.00 | Ref         |       |
| Father Present in Home    | 8768  |      |             | 0.097 |
| Yes                       | 46.4% (3706) | 0.88 | [0.76, 1.02] |       |
| No                        | 49.5% (384) | 1.00 | Ref         |       |
| Step-father Present in Home| 8768 |      |             | <0.001|
| Yes                       | 68.8% (53) | 2.55 | [1.57, 4.13] |       |
| No                        | 46.5% (4037) | 1.00 | Ref         |       |
| Step-brother Present in Home| 8768 |      |             | 0.098 |
| Yes                       | 56.9% (37) | 1.52 | [0.93, 2.48] |       |
| No                        | 46.6% (4053) | 1.00 | Ref         |       |
| Step-sister Present in Home| 8768 |      |             | 0.008 |
| Yes                       | 63.9% (39) | 2.04 | [1.21, 3.44] |       |
| No                        | 46.5% (4051) | 1.00 | Ref         |       |

**Step-father and step-sibling effects were attenuated by other features (parents had separated or divorced and the man’s recollection of unhappiness in this part of childhood); thus four variables remained: born to parents who resided outside Avon [OR 0.40, 95% CI 0.35, 0.45, P<0.0001]; having been breast fed [OR 0.68, 95% CI 0.59, 0.78, P<0.0001]; parents divorced or separated [OR 1.93; 95% CI 1.27, 2.92; P=0.002]; and the degree of unhappiness in early childhood recalled by the man [OR 1.21, 95% CI 1.05, 1.38, P = 0.006] (Table S4, Model B; Supplementary File 1).**

### Mid-childhood and adolescence

The ways in which the odds of a man having an ELOC varied for features of mid-childhood (ages 6–11) and adolescence (age 12–16) are shown in Table 4. The strongest positive associations concerned parents having divorced or separated, step-siblings or step-father being present and the degree of unhappiness felt during each time period. In contrast there were protective effects for presence of the biological father in the home. The presence of his mother at these time points appeared to be of marginal impact. Logistic regression involving the
Table 4. Associations between features of mid-childhood (6–11 yrs) and adolescence (12–15 yrs) and external locus of control (ELOC).

| Features of the father | MID CHILDHOOD | | ADOLESCENCE | |
|------------------------|---------------|---|----------------------------|---|
|                        | % (n) ELOC    | OR [95% CI] | P  | % (n) ELOC    | OR [95% CI] | P  |
| Mother Present in Home | N = 8768      |              | 0.021 | N = 8768      |              | 0.160 |
| Yes                    | 46.3 % (3708) | 0.84 [0.72, 0.97] | | 46.4 % (3728) | 0.90 [0.77, 1.04] | |
| No                     | 50.7% (382)   | 1.00 Ref     | | 49.1% (362)   | 1.00 Ref     | |
| Father Present in Home | N = 8768      |              | <0.0001 | N = 8768      |              | <0.0001 |
| Yes                    | 45.3% (3416)  | 0.68 [0.61, 0.77] | | 45.1% (3282)  | 0.69 [0.62, 0.77] | |
| No                     | 54.8% (674)   | 1.00 Ref     | | 54.4% (608)   | 1.00 Ref     | |
| Step-father Present in Home | N = 8768 |              | <0.0001 | N = 8768      |              | <0.0001 |
| Yes                    | 60.0% (144)   | 1.74 [1.34, 2.26] | | 57.2% (210)   | 1.56 [1.26, 1.93] | |
| No                     | 46.3% (3946)  | 1.00 Ref     | | 46.2% (3806)  | 1.00 Ref     | |
| Step-brother Present in Home | N = 8768 |              | <0.0001 | N = 8768      |              | 0.026 |
| Yes                    | 64.0% (64)    | 2.05 [1.36, 3.09] | | 55.7% (83)    | 1.45 [1.04, 2.01] | |
| No                     | 46.4% (4026)  | 1.00 Ref     | | 46.5% (4007)  | 1.00 Ref     | |
| Step-sister Present in Home | N = 8768 |              | <0.0001 | N = 8768      |              | 0.009 |
| Yes                    | 69.1% (67)    | 2.58 [1.67, 3.98] | | 58.3% (74)    | 1.61 [1.13, 2.29] | |
| No                     | 46.4% (4023)  | 1.00 Ref     | | 46.5% (4016)  | 1.00 Ref     | |
| Mother’s Partner Present | N = 8768 |              | <0.0001 | N = 8768      |              | 0.002 |
| Yes                    | 71.2% (52)    | 2.86 [1.72, 4.75] | | 61.0% (75)    | 1.80 [1.25, 2.59] | |
| No                     | 46.4% (4038)  | 1.00 Ref     | | 46.4% (4038)  | 1.00 Ref     | |
| Parents Divorced/Separated | N = 8768 |              | <0.0001 | N = 8768      |              | <0.0001 |
| Yes                    | 62.0% (259)   | 1.92 [1.57, 2.35] | | 58.5% (176)   | 1.64 [1.30, 2.07] | |
| No                     | 45.9% (3831)  | 1.00 Ref     | | 46.2% (3914)  | 1.00 Ref     | |
| Started Smoking Regularly | N = 8525 |              | <0.0001 | N = 8525      |              | <0.0001 |
| Yes                    | 74.2% (95)    | 3.34 [2.24, 4.97] | | 64.9% (524)   | 2.27 [1.95, 2.64] | |
| No                     | 46.3% (3887)  | 1.00 Ref     | | 44.8% (3458)  | 1.00 Ref     | |
| Recollection of Happiness | N = 8358 |              | <0.0001 | N = 8453      |              | <0.0001 |
| Very happy             | 45.0% (2353)  | 1.00 Ref     | | 45.6% (1880)  | 1.00 Ref     | |
| Moderately happy       | 49.6% (1272)  | 1.20 [1.10, 1.32] | | 48.0% (1522)  | 1.10 [1.00, 1.21] | |
| Not really happy        | 60.7% (227)   | 1.89 [1.52, 2.34] | | 52.3% (386)   | 1.31 [1.12, 2.53] | |
| Quite unhappy           | 71.1% (135)   | 3.00 [2.18, 4.13] | | 57.2% (139)   | 1.60 [1.23, 2.07] | |
| Very unhappy            | 69.9% (121)   | 2.78 [2.00, 3.87] | | | |

Combining the three age groups

Since there is much overlap between the factors entering the models for each age group (e.g. unhappiness appears in each, presence of the father in two), the surviving variables from each age group were offered together. The results are shown in Table 5 and Table S6 (Supplementary File 1). This demonstrated that the degree of unhappiness was particularly relevant if occurring in mid-childhood, but that presence of the father was important both in mid-childhood and adolescence. Starting regular smoking was important at both these time points. These
findings did not explain the associations with being breast fed or with being born within the study area (Avon), both of which remained in the model.

His social environment in childhood

A number of other aspects of his childhood were compared with his subsequent ELOC (Table 6). These included measures indicating contact with social, health and educational care of various sorts – such as being taken “into care”, living with foster parents, living in a children’s home, being taken into custody, seeing a child psychiatrist, having speech therapy and attending a “special school”, all of which were associated with increased risk of subsequent ELOC, as were other residential arrangements such as living with grandparents, other relatives or friends. The only residential category that indicated a LOC advantage concerned the men who had gone to a boarding school in adulthood. These included death of a relative, a parent or a sibling being in hospital, he himself being admitted to hospital, and moving to a new district (Table S8; Supplementary File 1).

Combining the traumatic and social environment models

The 12 variables concerning the traumatic events (Table S9; Supplementary File 1) were offered to stepwise regression to the seven from the social environment model. Only two dropped out – discovering he was adopted and being physically abused by his parents.

Final models

All variables concerning the man’s childhood which had survived the intra-domain analyses were offered together. Of the 26 variables, 15 were left in the model (Table S10; Supplementary File 1 and Model A in Table 8). The features remaining in the model included the following with protective associations: being born outside the study area (OR 0.40), his father being present in mid-childhood (0.64), being breast fed (0.72), attending boarding school (0.72), positive view of the warmth of his mother’s care of him (0.78), hospitalization of a parent (0.82) or of himself (0.84); in contrast the following variables were positively associated with ELOC: starting to smoke before the age of 11 (3.77), spending time in custody (3.02), mother’s partner being present in the home in mid-childhood (2.89), starting to smoke regularly in adolescence (2.09), attending a special school (1.83), unstable home (1.60), having a serious accident (1.31), and a friend dying (1.17).

When the three characteristics of the parents were offered to the factors remaining in Model A, a number of the descriptors of childhood dropped out. These included: presence of the father and of the mother’s partner, whether a parent, or he himself was
Table 6. Associations between features of the social environment in childhood and external locus of control (ELOC) for the men.

| Social Environment in childhood | % (n) | ELOC | OR [95% CI] | P   |
|---------------------------------|------|------|------------|-----|
| Attended a special school       | N=8768 |      |            | <0.0001 |
| Yes                             | 70.1% (176) |      | 2.76 [2.10, 3.63] |     |
| No                              | 46.0% (3914) |      | 1.00 Ref   |     |
| Saw a child psychiatrist        | N=8768 |      |            | <0.001 |
| Yes                             | 56.8% (167) |      | 1.53 [1.21, 1.93] |     |
| No                              | 46.3% (3923) |      | 1.00 Ref   |     |
| Had speech therapy              | N = 8768 |      |            | 0.007 |
| Yes                             | 54.4% (160) |      | 1.38 [1.09, 1.74] |     |
| No                              | 46.4% (3930) |      | 1.00 Ref   |     |
| Was “in care”                   | N = 8299 |      |            | <0.0001 |
| Yes                             | 61.7% (150) |      | 1.83 [1.40, 2.37] |     |
| No                              | 46.9% (3779) |      | 1.00 Ref   |     |
| Lived with grandparents         | N=8490 |      |            | <0.0001 |
| Yes                             | 57.8% (284) |      | 1.57 [1.31, 1.89] |     |
| No                              | 46.6% (3727) |      | 1.00 Ref   |     |
| Lived with other relatives      | N=8490 |      |            | <0.0001 |
| Yes                             | 59.9% (209) |      | 1.70 [1.37, 2.12] |     |
| No                              | 46.7% (3802) |      | 1.00 Ref   |     |
| Lived with friends              | N=8490 |      |            | <0.0001 |
| Yes                             | 59.1% (182) |      | 1.64 [1.30, 2.07] |     |
| No                              | 46.8% (3829) |      | 1.00 Ref   |     |
| Lived with foster parents       | N=8490 |      |            | <0.001 |
| Yes                             | 68.1% (49) |      | 2.40 [1.46, 3.94] |     |
| No                              | 47.1% (3962) |      | 1.00 Ref   |     |
| Went to boarding school         | N=8379 |      |            | <0.0001 |
| Yes                             | 66.9% (186) |      | 0.57 [0.47, 0.68] |     |
| No                              | 47.4% (3764) |      | 1.00 Ref   |     |
| Stayed in children’s home       | N = 8352 |      |            | <0.0001 |
| Yes                             | 66.9% (91) |      | 2.28 [1.59, 3.27] |     |
| No                              | 47.0% (3861) |      | 1.00 Ref   |     |
| Stayed in custody               | N=8325 |      |            | <0.0001 |
| Yes                             | 83.3% (169) |      | 5.75 [3.97, 8.33] |     |
| No                              | 46.4% (3767) |      | 1.00 Ref   |     |
| Left home before age 18         | N = 8443 |      |            | <0.0001 |
| Yes                             | 53.9% (856) |      | 1.39 [1.25, 1.55] |     |
| No                              | 45.7% (3129) |      | 1.00 Ref   |     |
| Stability of mother in household| N=8298 |      |            | <0.0001 |
| Always                          | 46.4% (2225) |      | 1.00 Ref   |     |
| Mostly                          | 48.1% (1520) |      | 1.07 [0.98, 1.17] |     |
| Rarely / never                  | 65.4% (223) |      | 2.18 [1.73, 2.75] |     |
| Stability of father in household| N=7940 |      |            | <0.0001 |
| Always                          | 44.5% (1938) |      | 1.00 Ref   |     |
| Mostly                          | 46.9% (1408) |      | 1.10 [1.01, 1.21] |     |
| Rarely ,never                   | 66.0% (382) |      | 2.42 [2.02, 2.91] |     |
| Overall stability of home       | N=8438 |      |            | <0.0001 |
| Very stable                     | 46.3% (1834) |      | 1.00 Ref   |     |
| Fairly stable                   | 46.0% (1686) |      | 0.99 [0.90, 1.08] |     |
| Unstable                        | 58.7% (338) |      | 1.65 [1.38, 1.97] |     |
| Very unstable                   | 77.2% (183) |      | 3.93 [2.88, 5.36] |     |
| Maternal care score           | N=8768 |      |            | <0.0001 |
| <19                             | 57.2% (1094) |      | 2.00 [1.74, 2.30] |     |
| 19–21                           | 49.2% (870) |      | 1.46 [1.26, 1.68] |     |
| 22–23                           | 42.5% (1573) |      | 1.11 [0.98, 1.26] |     |
| 24                              | 40.0% (553) |      | 1.00 Ref   |     |

*the higher the score the warmer the care.*
Table 7. Unadjusted associations between experience of life events in childhood and external locus of control (ELOC).

| Experiences in childhood       | % (n) ELOC | OR [95% CI] | P     |
|-------------------------------|------------|-------------|-------|
| A parent died                 | N=8062     | 0.010       |       |
| Yes                           | 51.7% (243) | 1.28 [1.06, 1.54] |       |
| No                            | 45.6% (3459) | 1.00 Ref    |       |
| A sibling died                | N=8062     | 0.005       |       |
| Yes                           | 54.3% (145) | 1.42 [1.11, 1.81] |       |
| No                            | 45.6% (3557) | 1.00 Ref    |       |
| A relative died               | N = 8062   | <0.0001     |       |
| Yes                           | 43.7% (2213) | 0.79 [0.72, 0.86] |       |
| No                            | 49.6% (3557) | 1.00 Ref    |       |
| A friend died                 | N = 8062   | 0.002       |       |
| Yes                           | 49.2% (850) | 1.18 [1.06,1.31] |       |
| No                            | 45.0% (2852) | 1.00 Ref    |       |
| Parent seriously ill          | N=8062     | 0.212       |       |
| Yes                           | 44.7% (836) | 0.94 [0.84, 1.04] |       |
| No                            | 46.3% (2866) | 1.00 Ref    |       |
| Parent in hospital            | N=8062     | <0.0001     |       |
| Yes                           | 42.6% (1464) | 0.79 [0.73, 0.87] |       |
| No                            | 48.4% (2238) | 1.00 Ref    |       |
| Was seriously ill             | N=8062     | 0.766       |       |
| Yes                           | 45.4% (394) | 0.98 [0.85, 1.13] |       |
| No                            | 46.0% (3308) | 1.00 Ref    |       |
| Was admitted to hospital      | N=8062     | <0.0001     |       |
| Yes                           | 43.1% (1422) | 0.83 [0.76, 0.90] |       |
| No                            | 47.8% (2280) | 1.00 Ref    |       |
| A sibling was seriously ill   | N=8062     | 0.823       |       |
| Yes                           | 45.6% (406) | 0.98 [0.86, 1.13] |       |
| No                            | 46.0% (3296) | 1.00 Ref    |       |
| A sibling was in hospital     | N = 8062   | 0.005       |       |
| Yes                           | 43.2% (865) | 0.86 [0.78,0.96] |       |
| No                            | 46.8% (2837) | 1.00 Ref    |       |
| Parent had a serious accident | N=8062     | 0.539       |       |
| Yes                           | 47.2% (246) | 1.06 [0.89, 1.26] |       |
| No                            | 45.8% (3456) | 1.00 Ref    |       |
| Had a serious accident        | N=8062     | <0.001      |       |
| Yes                           | 52.4% (383) | 1.33 [1.14, 1.55] |       |
| No                            | 45.3% (3319) | 1.00 Ref    |       |
| Partner became pregnant       | N=8062     | <0.0001     |       |
| Yes                           | 68.0% (155) | 2.57 [1.94, 3.40] |       |
| No                            | 45.3% (3547) | 1.00 Ref    |       |
| Experiences in childhood                                                                 | % (n) ELOC | OR [95% CI]   | P     |
|-------------------------------------------------------------------------------------------|------------|---------------|-------|
| A parent was imprisoned                                                                  | N = 8062   |               | <0.0001|
| Yes                                                                                      | 76.0% (73) | 3.79 [2.37, 6.07] |       |
| No                                                                                       | 45.6% (3629) | 1.00 Ref   |       |
| Was physically abused by parent                                                          | N = 8062   |               | <0.0001|
| Yes                                                                                      | 58.9% (224) | 1.74 [1.41, 2.14] |       |
| No                                                                                       | 45.3% (3478) | 1.00 Ref   |       |
| Parents separated                                                                        | N = 8062   |               | <0.0001|
| Yes                                                                                      | 58.2% (690) | 1.79 [1.58, 2.03] |       |
| No                                                                                       | 43.8% (3012) | 1.00 Ref   |       |
| Parents divorced                                                                        | N = 8062   |               | <0.0001|
| Yes                                                                                      | 58.8% (569) | 1.81 [1.58, 2.074] |      |
| No                                                                                       | 44.2% (3133) | 1.00 Ref |       |
| A parent remarried                                                                       | N = 8062   |               | <0.0001|
| Yes                                                                                      | 58.6% (441) | 1.75 [1.51, 2.04] |       |
| No                                                                                       | 44.6% (3261) | 1.00 Ref |       |
| Was emotionally abused by parent                                                         | N = 8062   |               | 0.019 |
| Yes                                                                                      | 50.7% (278) | 1.23 [1.03, 1.46] |       |
| No                                                                                       | 45.6% (3424) | 1.00 Ref |       |
| Parents had serious arguments                                                            | N = 8062   |               | <0.001 |
| Yes                                                                                      | 48.9% (1216) | 1.19 [1.08, 1.31] |       |
| No                                                                                       | 44.6% (2486) | 1.00 Ref |       |
| Was sexually abused                                                                      | N = 8062   |               | 0.479 |
| Yes                                                                                      | 49.5% (48)  | 1.16 [0.77, 1.72] |       |
| No                                                                                       | 45.9% (3654) | 1.00 Ref |       |
| A parent was mentally ill                                                                | N = 8062   |               | 0.778 |
| Yes                                                                                      | 45.1% (134) | 0.97 [0.77, 1.22] |       |
| No                                                                                       | 45.9% (3568) | 1.00 Ref |       |
| Discovered was adopted                                                                   | N = 8062   |               | 0.009 |
| Yes                                                                                      | 55.9% (95)  | 1.50 [1.11, 2.04] |       |
| No                                                                                       | 45.7% (3607) | 1.00 Ref |       |
| Moved to a new district                                                                  | N = 8062   |               | <0.0001|
| Yes                                                                                      | 41.5% (1097) | 0.77 [0.70, 0.84] |       |
| No                                                                                       | 48.1% (2605) | 1.00 Ref |       |
| In trouble with police                                                                   | N = 8062   |               | <0.0001|
| Yes                                                                                      | 63.6% (934) | 2.42 [2.15, 2.72] |       |
| No                                                                                       | 42.0% (2768) | 1.00 Ref |       |
| Was suspended from school                                                                | N = 8062   |               | <0.0001|
| Yes                                                                                      | 71.1% (523)  | 3.20 [2.71, 3.78] |       |
| No                                                                                       | 43.4% (3179) | 1.00 Ref |       |
| Family finances deteriorated                                                             | N = 8062   |               | 0.001 |
| Yes                                                                                      | 50.2% (618)  | 1.22 [1.08, 1.38] |       |
| No                                                                                       | 45.1% (3084) | 1.00 Ref |       |
Table 8. Final models concerning childhood (Model A), and combined with parental characteristics (Model B) predicting the man’s ELOC.

| FEATURE                        | Model A               | Model B               |
|--------------------------------|-----------------------|-----------------------|
|                                | OR [95% CI]           | P                     | OR [95% CI]           | P                     |
| In Infancy                     |                       |                       |                       |                       |
| Born outside Avon              | 0.40 [0.35,0.45]      | <0.0001               | 0.51 [0.43,0.61]      | <0.0001               |
| Was breast fed                 | 0.72 [0.62,0.82]      | <0.0001               | 0.77 [0.65, 0.91]     | 0.003                 |
| In Mid-Childhood               |                       |                       |                       |                       |
| Father present                 | 0.64 [0.51,0.79]      | <0.0001               | 0.77 [0.65, 0.91]     | 0.003                 |
| Mother’s partner present       | 2.89 [1.19,7.02]      | 0.019                 | DNE                   |                       |
| Smoked regularly               | 3.77 [1.87,7.60]      | <0.001                | 4.24 [1.63,11.0]      | 0.003                 |
| Adolescence                    |                       |                       |                       |                       |
| Started smoking regularly      | 2.09 [1.66,2.62]      | <0.0001               | 1.77 [1.32,2.38]      | <0.001               |
| Traumatic Events               |                       |                       |                       |                       |
| Friend died                    | 1.17 [1.00,1.37]      | 0.046                 | 1.23 [1.02,1.49]      | 0.032                 |
| Parent hospitalized            | 0.82 [0.72,0.93]      | 0.003                 | DNE                   |                       |
| Admitted to hospital           | 0.84 [0.74,0.96]      | 0.013                 | DNE                   |                       |
| Had serious accident           | 1.31 [1.04,1.65]      | 0.023                 | DNE                   |                       |
| Social Environment             |                       |                       |                       |                       |
| Attended special school        | 1.83 [1.23,2.73]      | 0.003                 | 1.93 [1.18,3.15]      | 0.009                 |
| Went to boarding school        | 0.72 [0.54,0.95]      | 0.022                 | DNE                   |                       |
| Spent time in custody          | 3.02 [1.71,5.32]      | <0.001                | 2.53 [1.22,5.23]      | 0.012                 |
| Home described as unstable     | 1.60 [1.33,1.93]      | <0.0001               | 1.76 [1.38,2.25]      | <0.0001               |
| Maternal care score            | 0.78 [0.72,0.85]      | <0.0001               | 0.78 [0.71,0.87]      | <0.0001               |
| Characteristics of his parents |                       |                       |                       |                       |
| Mother’s year of birth         | -                     | 1.32 [1.19,1.47]      | <0.0001               |
| Mother smoked prenatally       | -                     | 1.20 [1.02,1.42]      | 0.029                 |
| Father’s social group          | -                     | 1.16 [1.11,1.21]      | <0.0001               |
| Number in model                | 4369                  | 2939                  |
| GOF                            | 9.22                   | 9.87                  |

DNE = Did not enter; GOF = Goodness of fit

hospitalized in childhood, or he had a serious accident, or went to boarding school. The final model showed an increase in GOF from 9.22 to 9.87, but the number of participants in the model dropped from 4369 to 2939 (Table 8 and Table S11; Supplementary File 1).

Summary of the antecedents for men and women

The ways in which the different results from each of the intra-domain models contributed to the final models is shown in Table 9. In general the GOF results show that amalgamation of each of the domains has increased the GOF. However it is notable that the early childhood variables (EC) appear to be less, and the traumatic events (TE) and adolescence (A) variables more important among the men than was previously shown for the women (Golding et al., 2017b). Overall there were fewer variables in the Final model for the men (12) than the women (20), but the GOF was greater for the men (9.87 v 8.37).

A comparison of the results for each item is shown for the men and women in Table 10 using the two final models involving the childhood circumstances. We do not show the results incorporating the demographic features of the parents as the numbers reduced substantially in this model for the men; however we indicate the variables that drop out of the model when the parental demographic features are introduced. The table highlights the results in common between the men and the women. These include associations between ELOC and starting to smoke regularly before the age of 11, and having a friend die. Associations with
### Table 9. Summary of goodness of fit (GOF) in models concerning childhood and parental characteristics, comparing results for men and women.

| Model                  | MAN     | WOMAN   |       | MAN     | WOMAN   |
|------------------------|---------|---------|-------|---------|---------|
|                        | N       | No. variables | GOF   | N       | No. variables | GOF   |
| EC                     | 4056    | 4        | 4.72  | 8614    | 6        | 5.79  |
| MC                     | 8188    | 4        | 1.78  | 12,090  | 5        | 1.99  |
| A                      | 8279    | 5        | 2.21  | 12,574  | 3        | 1.26  |
| EC + MC + A            | 4498    | 9        | 7.16  | 8945    | 10       | 6.14  |
| TE                     | 8062    | 12       | 2.34  | 11,843  | 10       | 1.94  |
| SE                     | 7957    | 7        | 3.19  | 10,851  | 11       | 2.84  |
| All childhood          | 4369    | 15       | 9.22  | 8673    | 22       | 7.50  |
| M                      | 4067    | 3        | 3.83  | 10,642  | 4        | 4.34  |
| F                      | 3578    | 4        | 4.38  | 8110    | 5        | 4.64  |
| M + F                  | 3652    | 5        | 4.73  | 5975    | 9        | 5.43  |
| ALL                    | 2939    | 12       | 9.87  | 7285    | 20       | 8.37  |

A = Adolescence; EC = Early Childhood (<6y); F = Father; M = Mother; MC = Mid-childhood (6–11y); SE = Social Environment; TE = Traumatic Events; GOF = Goodness of fit measure

### Table 10. Comparison of childhood features in the final model for men and women.

| Childhood characteristic | Men (n=4369) | Women (n=8675) |
|--------------------------|--------------|----------------|
| **In Early Childhood**   |              |                |
| Born outside Avon        | 0.40 [0.35, 0.45] | 0.55 [0.50, 0.61] |
| Was breast fed           | 0.72 [0.62, 0.82] | 0.87 [0.79, 0.96] |
| Had a birthmark          | -            | 1.19 [1.07, 1.32] |
| No. older siblings       | -            | 1.26 [1.12, 1.41] |
| Father present           | -            | 0.62 [0.51, 0.76] |
| Year of birth            | -            | 1.53 [1.43, 1.65] |
| **In Mid-childhood**     |              |                |
| Father present           | 0.64 [0.51, 0.79] | - |
| Mother’s partner present | 2.89 [1.19, 7.02] | - |
| Smoked regularly         | 3.77 [1.87, 7.60] | 1.72 [1.06, 2.78] |
| Degree of happiness      | -            | 0.88 [0.81, 0.95] |
| **In Adolescence**       |              |                |
| Started smoking regularly| 2.09 [1.66, 2.62] | - |
| Mother present           | -            | 0.79 [0.63, 1.00] |
| Social Environment       |              |                |
| Maternal care score      | 0.78 [0.72, 0.85] | 0.77 [0.72, 0.84] |
| Boarding school          | 0.72 [0.54, 0.95] | 0.46 [0.35, 0.61] |
| **Social Environment**   |              |                |
| Maternal care score      | 0.78 [0.72, 0.85] | 0.77 [0.72, 0.84] |
| Boarding school          | 0.72 [0.54, 0.95] | 0.46 [0.35, 0.61] |

**Childhood characteristic** | **Men (n=4369)** | **Women (n=8675)** |
|-----------------------------|------------------|--------------------|
| Home was unstable           | 1.60 [1.33, 1.93] | -                  |
| Attended special school     | 1.83 [1.23, 2.73] | -                  |
| Was in custody              | 3.02 [1.71, 5.32] | -                  |
| Attended child psychiatrist | -                | 1.36 [1.06, 1.76] |
| Lived with grandparents     | -                | 1.40 [1.11, 1.76] |
| Left home before aged 18    | -                | 1.41 [1.24, 1.59] |
| Stayed elsewhere            | -                | 0.78 [0.64, 0.95] |
| **Traumatic Events**        |                  |                    |
| Friend died                 | 1.17 [1.00, 1.37] | 1.21 [1.07, 1.39] |
| Relative died               | -                | 0.85 [0.77, 0.93] |
| Parent hospitalized         | 0.82 [0.72, 0.93] | 0.90 [0.82, 0.99] |
| Sibling hospitalized        | -                | 0.84 [0.75, 0.94] |
| Parent had serious accident | -                | 1.45 [1.16, 1.82] |
| Was hospitalized            | 0.84 [0.74, 0.96] | -                  |
| Had serious accident        | 1.31 [1.04, 1.65] | -                  |
| Physically abused by parent | -                | 0.73 [0.55, 0.98] |
| Parent was mentally ill     | -                | 0.65 [0.51, 0.82] |

*Did not enter when features of the parents were entered
increased internality common to both were warm maternal care, being breast fed, being born in an area other than that where they currently live (Avon), attending boarding school and having a parent admitted to hospital.

Discussion
Men and women appear to have more in common with one another than not when it comes to antecedents of their loci of control; that is suggested by our results. At least in terms of the characteristics included in this study, men and women appear to have a common core of experiences such as maternal warmth (as reflected in the maternal care scores, and being breast fed), consistency (as shown by a stable home), and greater satisfaction with life (as shown by a lower rate of unhappiness) that may underlie a tendency to be more internal than external for both men and women. Antecedents like these describe a home situation that provides what is needed for children to feel comfortable and safe enough to explore their environments and to learn more about the contingencies existing between their behavior and outcomes.

Since maternal warmth was found to be important for internality and lack of it for externality in both men and women, it is apparent that efforts to strengthen the mother-son relationship might pay off in increased likelihood of internality in men as well as in women. Several authors (Carton & Nowicki, 1994; Rotter, 1966, Rotter, 1975, Rotter, 1990; Schneewind, 1997) have indicated that the tone of the mother-son relationship sets the stage for initially learning how to interact with the environment such that if the relationship is positive and supportive, it provides the child with a comfortable vantage point to become aware of his behavioral impact.

However, while mothers’ warmth was significant for men, it also may be true that an additional protective factor for them was the presence of the biological father in the home, especially in mid-childhood. The presence of the father may strengthen the stability of the family and, in some cases, present the male child with an accessible same sex model of internality if that is the father’s orientation. Further study is needed to see if fathers who stay with the family are more likely to be internal; conversely if they are external, how might that affect the development of LOC in their sons. In any case, this finding suggests that gaining additional insight into the father-son relationship could be helpful in identifying significant factors associated with the development of internal or external control expectancies in the sons.

One additional difference deserves some comment and that is the fact that all participants born outside of Avon were likely to be more internal than their peers. How does that fit in with the maternal warmth, home stability, and the presence of the father? One possible explanation may be that if sons who have a warm and stable household move to live in a different location, the change would give them a greater number of environmental opportunities to learn contingencies necessary for the development of internality. The same reasoning is possible for the apparent benefits of attending boarding school. If true, it suggests that a strong, stable, family situation may provide an important foundation for reacting positively when experiencing change in living situations. It is also possible that the opposite is true. That is, if the family situation lacks warmth and is unstable then moving to a new environment might be overwhelming and facilitate the development of externality.

Smoking exposures
Previous studies (Golding et al., 2017a; Golding et al., 2017b) had shown that women who were externally oriented had an increased risk of (a) having been exposed in utero to their mother’s smoking, and (b) being a regular smoker themselves by the age of 11. Similarly, the same smoking factors were demonstrated for the men (Table 8) with adjusted odds ratios of 1.20 [95%CI 1.02, 1.42] and 3.77 [1.87, 7.60] respectively. These factors were independently associated and were not explained by social conditions. This raises the question as to whether mothers who smoke are themselves more externally oriented, and hence more likely to permit their offspring to smoke in mid-childhood or whether childhood exposure to cigarette smoke has a biological effect on the developing brain resulting in susceptibility to ELOC.

While it is most likely that there are psychological and social reasons for maternal prenatal smoking to be associated with ELOC, a biological effect is plausible: animal experiments find that fetal exposure to a smoking mother results in an increased risk of poor neurocognitive functioning, results that have been mirrored by observational studies in humans (Bublitz & Stroud, 2012; Cornelius et al., 2011; Wickström, 2007). Brain imaging techniques have demonstrated reductions in grey matter volume and density among smokers (Dome et al., 2010), suggesting a biological effect since the grey matter includes regions of the brain involved in memory, decision making, and self-control and two imaging studies have demonstrated an association between hippocampal volume and LOC in young adults (Miller & Alston, 2008; Pruessner et al., 2005).

It is feasible that some of the features that we have shown to be associated with LOC are a consequence of the externality of the individuals in childhood. This could explain the strong association with starting to smoke by age 11, but cannot explain the associations with prenatal exposure – although this may be the result of having an externally oriented mother. However, the correlation between the LOC orientation of mothers and their children is generally low so may not be a plausible interpretation (Schneewind, 1997).

Strengths of the study
The major strengths of the study are the large numbers of individuals involved, the fact that they were selected from a geographical population, and that the questions asked of both the men and women considering their backgrounds were identical. Both the men and women were asked at the same point in their life cycle – i.e. when about to become a parent – although the men were, on average, 3 years older than the women.
Limitations of the study
There are a number of limitations to this study, the most important of which is likely to be the amount of missing data concerning the childhood of the men compared with the women. This is a general observation – that men are far less interested in their backgrounds and family history than are women. This is particularly true of men who had little contact with their fathers, and who are particularly likely to drop out of any model. The non-responders were also likely to be weighted with ELOC individuals, and were likely to fall within the category ‘missing not at random’. We therefore decided not to impute the missing data (Sterne et al., 2009).

A further limitation of both the study of the women and the men concerns the Parent Bonding Index (Parker et al., 1979), one trait within which was shown to be strongly protective for both the men and women (maternal care). For reasons of space on the questionnaires, the individuals were only asked to complete the relevant questions in regard to their relationship with their mothers, not their fathers. In retrospect this was unfortunate since presence of the father was in the final model of both men and women, albeit with the focus at different time points (women in early childhood; men in mid-childhood).

Finally it must be admitted that the findings in one small area of the world may not be relevant to other areas of either the developed or developing world.

We note that the retrospective data analyzed here were collected at a single point in time, and that it will be important to study the development of LOC prospectively through the childhood of the offspring of these men and their partners to verify and understand these results. The plans for such a study are in hand.

Data availability
In order to preserve confidentiality of the participants it is important that the ALSPAC access rules are taken into account. The ALSPAC study website contains details of all the data that are available through a fully searchable data dictionary: http://www.bristol.ac.uk/alspac/researchers/data-access/data-dictionary/.

Data can be obtained by bona fide researchers after application to the ALSPAC Executive Committee (http://www.bristol.ac.uk/alspac/researchers/access/).

Competing interests
No competing interests were disclosed.

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We are extremely grateful to all the families who took part in this study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses.

Supplementary material
Supplementary File 1 – Document containing Supplementary Tables 1-11

Click here to access the data.

Table S1. Distribution of the demographic variables concerning the men in the study.
Table S2. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4) in regard to his mother’s demographic features.
Table S3. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his father.
Table S4. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his early childhood.
Table S5a. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his mid-childhood.
Table S5b. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his adolescence.
Table S6. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his childhood and adolescence.
Table S7. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his social environment in childhood.
Table S8. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): Traumas in his childhood.
Table S9. Backwards step-wise logistic regression of the man’s locus of control score (≥4 versus <4): his childhood traumas and social/medical environment.

Table S10. The childhood and adolescence of father, including childhood traumas and social environment.

Table S11. The childhood and adolescence of father, including childhood traumas, social environment and details of his parents.

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Locus of control refers to people's generalized expectancies about the origin of rewards (e.g. success) and punishment (e.g. failure, bad things happening to them) in the world. As Golding et al. review, locus of control does differ from self-efficacy and attribution of causes; however, there is some overlap. Locus of control is a moderately stable individual difference. However, there is still some uncertainty about why some people have external or internal control expectations. This study investigated a large number of men while their partners were expecting a child. This was possibly as part of the Avon Longitudinal Study of Parents and Children (ALSPAC), one of the leading pregnancy to adulthood cohort studies in the world. The men completed a number of questionnaires about their family of origin and their life course behaviour (e.g. smoking). The same scales were also completed by the pregnant women and the results have been previously reported by the same group.

The statistical approach, a theory-free exosome approach in hierarchical steps using backward logistic regression is well described. In the final model, after all significant predictor variables were controlled for each other, 12 variables survived for men compared to 20 variables in the previous analysis of women. The results are clearly presented and Table 10 provides a nice comparative summary between the findings on men and women.

Some of the findings are consistent with previous literature in smaller samples such that more positive maternal care and father presence or breastfeeding are related to less external control while starting to smoke early, having problems in childhood/adolescence which were gendered (e.g. for men: custody; females attended child psychiatrist) were found to be related to more external locus of control. These are easily interpreted as done by the authors that good parenting helps developing internal locus of control and that stresses may be related to external locus of control. However, there are few results that do not neatly fit into this picture of how locus of control develops. It is puzzling that having a parent or oneself who was hospitalized, being born outside Avon, being sent to boarding school or having had a relative die, being physically abused by a parent or having a mentally ill parent (in women) led to more internal locus of control. All of these are potential moderate to severe stressors and it seems that having to master these stresses, i.e. learn coping mechanisms, also increases the belief that the rewards are under one's own control. Similar to what has been found in resiliency research, it may be important that children and adolescents are exposed to moderate stressors to learn of how to deal with them and bounce back. Similarly, as shown here it may foster internal locus of control. This would also fit with Baumrind's concept of tough love: clear rules and exposure to challenges within warm and supportive parenting.

Alternatively, it may be that those who experienced less good maternal care may have particularly
benefited from staying elsewhere, boarding school or moving into a different environment. This could be detected by allowing for statistical interaction terms (e.g. maternal care x boarding school) or subgroup analysis, perhaps something that could be explored. Furthermore, self-rated locus of control provides information about general expectancy, however, it does not tell us how realistic it is or whether it is related to actual rewards. It would be interesting to know whether a higher internal control expectancy in those who had adverse experiences does also reap the same rewards as in those who had mainly positive parenting as a precursor?

A limitation of the study as acknowledged by the authors is that it is based on retrospective data. Another issue not discussed by the authors is that the questions about the family and life course were asked during pregnancy of their future offspring. It has been previously shown that pregnancy is a period of heightened attention to thoughts such as: “How a good a mother will I be? for expecting mothers while expecting fathers worry about: “Will we have enough money to provide?” and “how will the baby affect my relationship with my partner?”. Thus, during pregnancy recall of information may be partly determined by current concerns and thus it may not be surprising that expectant mothers recalled more about their own parenting than men.

The future for investigating precursors of locus of control is bright for these authors. The ALSPAC study has collected prospectively data on the offspring of the parents included in this study and the previous report on women removing any concerns about retrospective recall. It will allow to look at other variables that were not included in this study such as how sibling or peer relationships which are important socialization drivers in childhood and adolescence, may be related to locus of control development. Finally, there is the exciting prospect of investigating cross-generational transmission of expectancies. Thus, this study has laid the foundation to guide some of the future prospective analyses.

**Is the work clearly and accurately presented and does it cite the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
Yes

**Are all the source data underlying the results available to ensure full reproducibility?**
Yes

**Are the conclusions drawn adequately supported by the results?**
Partly

**Competing Interests:** No competing interests were disclosed.

**Referee Expertise:** Developmental psychopathology, developmental psychology

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.
Aleksandra Kostic  
Faculty of Philosophy, Study Group for Psychology, University of Niš, Niš, Serbia

Over the last decades, numerous studies have shown that the locus of control is a very significant variable which "permeates" and shapes different aspects of an individual's life (personality traits, achievement, professional success, social adaptation and the quality of social interactions). In most studies, the authors researched the factors which caused the domination of either internal or external control in children. I consider this research valuable because there are not many studies which have investigated the antecedents of the loci of control in adult men, despite the importance of understanding the process of development of the internal, i.e., external control in the members of this population. Since in their earlier study, the same group of researchers discovered a series of independent factors which were connected to the locus of control in women, the results of the new study enabled the comparison of a series of factors which were connected with the development of the locus of control in men. Of course, both studies used the same theoretical and methodological concepts which enabled the comparison of potential similarities in identified factors on the basis of the information about the parents and the childhood of the respondent.

The study included a large number of very important variables (five different groups) which were considered as the potential antecedents of the locus of control. Those were the pieces of information about the demographic background of those men's parents, about the respondents' births and early childhood (6 years), about the characteristics of their mid-childhood (6–11 years) and adolescence (12–15 years), about possible traumatic events during their childhood, as well as about their social environment during childhood. The researchers also collected certain information about the parents: their level of education, occupation, ethnic background, stability and predictability of their behaviour. Additionally, the researchers gathered the data on the respondents' own experience of whether their childhood was happy (childhood happiness).

The answers to the research questions were obtained by applying adequate standard statistical techniques. The results of the study are particularly important due to a large number of respondents who were included in the research and due to the applied research procedure.

The results of the research indicate that the antecedents of the locus of control in men and women are common. Similar experiences during childhood with the mother who is warm, supportive and responsive, who breastfeeds and who has a stable behaviour represents a good basis for the development of the internal locus of control of respondents of both male and female genders (the factors have been identified in the earlier study by the same researchers).

I am very pleased with all of the segments of the presented study: an excellent theoretical framework, good problematization, appropriate methodology, logical results as well as their interpretation. The researchers are aware of the limitations of their study.

Is the work clearly and accurately presented and does it cite the current literature? Yes
Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

**Competing Interests:** No competing interests were disclosed.

**Referee Expertise:** Social psychology field (communication, social interaction, self-perception, social perception, time perspective, recognition of emotion from facial expression, self-control)

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.