LOCUS OF CONTROL: ANTECEDENTS, CONSEQUENCES AND INTERVENTIONS USING ROTTER'S DEFINITION

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LOCUS OF CONTROL: ANTECEDENTS, CONSEQUENCES AND INTERVENTIONS USING ROTTER'S DEFINITION

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EDITORIAL
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Editorial: Locus of Control: Antecedents, Consequences and Interventions Using Rotter's Definition

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Editorial on the Research Topic

Locus of Control: Antecedents, Consequences and Interventions Using Rotter's Definition

Locus of control (LOC) is at the same time, one of the most popular and yet one of the most misused personality attributes in the social sciences. It was introduced into psychology in 1966 by Julian Rotter who conceptualized it as a generalized expectancy within his Social Learning Theory and defined it as follows:

"Internal vs. external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristic vs. the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues." (Rotter, 1966).

Although the number of studies with LOC as a major variable reaches into the thousands and research continues at a brisk pace up to the present day across disciplines, the way in which investigators have eroded, ignored, and misapplied Rotter's original definition of LOC is cause for scientific concern. Without an agreed upon definition of LOC and reliable ways of measuring it based on that definition, generalization across studies becomes difficult if not impossible.

The purpose of studies completed within this topic was to use Rotter's definition of LOC and measures of LOC consistent with that definition to investigate (1) the stability and change of children's and adults' LOC over time; Nowicki et al.(a); (2) antecedents of children's and adults' LOC [Carton et al.; Nowicki et al.(b)]; (3) the association of parents' prenatal LOC with children's academic and social outcomes [Golding, Gregory, Ellis, Nunes, et al.; Nowicki et al.(c); Golding, Gregory, Ellis, Iles-Caven, et al.]; (4) the association between change in parents LOC over time (6 years) and children's social success or failure [Nowicki et al.(d); Nowicki et al.(e)]; (5) the associations of children's LOC and internalizing and externalizing problems (Flores et al.); depression (Costantini et al.; Sullivan et al.) and epilepsy (Wolf et al.); and (6) the viability of interventions focused on changing LOC (Tyler et al.).

Researchers within this topic gathered data by using construct valid tests for adults and children developed to be consistent with Rotter's definition of LOC as a generalized expectancy. Although

some past studies have used measures of LOC that were dubious (e.g., one or two items plucked from a non-LOC scale) to evaluate the validity of LOC, the present studies were among the first to produce longitudinal information about the stability over time of LOC in children and adults (more stable in adults than children) and the impact of prenatal parental LOC on children's subsequent outcomes. Researchers also found that the greater the degree of externality in prenatal parents' LOC, the more negative were the children's outcomes in sleeping, eating, and emotional lability early in life and social/emotional adjustment and cognitive performance later in childhood. The association of prenatal parental LOC with children's outcomes was further supported by findings showing a significant association between parents' change toward internality over time (6 years) and more positive social and academic outcomes in their children when compared to parent child outcomes associated with parent LOC that remained the same or became more external over time.

Findings that parents' LOC is associated with children's outcomes suggests looking at the possibility that interventions focused on changing parental externality before children are born may be worthwhile. Support for this possibility was found in results indicating parental change toward internality was associated with positive child outcomes (as reflected in children's personal and social outcomes as rated by teachers). Results from another study indicated improvements in the parental relationship and improvement in their economic conditions were associated with parents becoming more internal. Although, cause and effect cannot be assigned, the findings suggest future research should be directed at evaluating if strengthening the parental dyad relationship and improving the family financial situations would result in parents changing toward internality and children's outcomes becoming more positive.

Other topic studies revealed more about possible parental behaviors, attitudes and actions related to children's LOC. Since, the last review of parental antecedents of children's LOC was published over a quarter century ago, a recent update was needed. What it found was that parents disciplinary actions characterized by authoritative approaches and parents more often contingently reinforcing their children's behavior/outcome sequences (as observed in laboratory interactions) are associated with greater internality. However, since there have been only a few observational studies of parent child interactions there is a need for more investigations spanning children at different ages of development.

A final set of studies within the LOC topic gathered information on associations between children's LOC and their personal, social, and physical outcomes. A longitudinal study of Spanish speaking children in northern Chile produced similar associations between children's externality and a greater frequency of internalizing and externalizing problems to those found previously with English speaking participants. Other studies revealed how internal LOC acts as a mediator to buffer against the development of depression in young high-risk children from compromised environments; a result found in high-risk adolescent children as well. Considering the LOC, depression association, the topic study that focused on a strength-based intervention with offenders to improve their LOC may have relevance for other populations of children. In any case, there is a general need for research to illuminate LOC antecedents as possible targets for inclusion in intervention programs to help children develop internality as a way to prevent depression.

A final study dealt with the impact of a chronic disease, in this case epilepsy, on children's LOC. When children experience a serious disease and/or disability like epilepsy they may erroneously "learn" to be more helpless than they actually are to deal with the affliction and its consequences. Children need the help of caretakers to learn the full impact of what outcomes their behavior is tied to so they can be active participants not only in their treatment, but in shaping their lives outside of treatment.

The take home message from this set of studies is that LOC as defined by Rotter and measured with scales consistent with his definition remains an important construct. The degree to which individuals view the connection between what they do and what happens to them appears to have relevance for parents expecting a child and in children dealing with social interactions, academic achievement, and/or chronic mental or physical disease. Because of the findings, more research closely tied to Rotter's social learning theory is needed to identify relevant antecedents of LOC expectancies and valid interventions to help children and adults learn to develop the full extent of their internality.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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ORIGINAL RESEARCH
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The Impact of Prenatal Parental Locus of Control on Children's Psychological Outcomes in Infancy and Early Childhood: A Prospective 5 Year Study

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Locus of control is one of the most widely studied concepts in the history of personality psychology. In spite of its popularity and its associations with numerous relevant outcomes, the ability of locus of control to predict future behaviors involving parenting effectiveness has been under researched. The few parent locus of control children's outcome studies are characterized by cross-sectional methodologies that focus on mothers. The present study uses a prospective methodology to compare data on mothers' and fathers' locus of control with their child's behavior outcomes from a large scale research project, the Avon Longitudinal Study of Parents and Children (ALSPAC). Based on Rotter's Social Learning Theory published in 1954 and past empirical research, it was predicted and found that parent internality was associated with more positive child outcomes than parent externality. More specifically, when both parents were internal, their children had more positive outcomes in sleeping, eating, and tantrum behavior as compared to any other parent locus of control combination. However external parents had a less restrictive attitude which appeared to have a more beneficial effect on picky eating. Results confirmed how important parent locus of control is in the lives of children. Based on the findings, researchers are urged to develop interventions to change advice to parents and promote more internal locus of control among parents.

Keywords: ALSPAC, parental prenatal locus of control, child behavior, parenting skills, picky eating, sleep problems, temper tantrums

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INTRODUCTION

Fifty years ago Rotter (1966) published a study that has been cited in thousands of publications. In it, he introduced the concept of locus of control and provided a scale to measure it. He defined locus of control as a generalized problem solving expectancy.

"Internal vs. external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics vs. the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues." (Rotter, 1966).

His article has stimulated a remarkable amount of research over the past half century. A search of PsychInfo resulted in 17,812 articles with a keyword "locus of control" as of summer 2015, with 6,600 of these appearing after 1996 (1,425 between 2010 and 2015). Locus of control has sustained itself as a concept for psychological study for a half century (Nowicki and Duke, 2016).

During the half century since Rotter published his article others have offered a variety of definitions and methods for measuring the locus of control construct. Unfortunately some researchers have defined locus of control and used it in ways that are not consistent with Rotter's original definition and intent. Skinner (1996) found over 100 different definitions of locus of control and others (e.g., Furnham and Steele, 1993) have shown that scores from different locus of control scales often fail to correlate strongly or not at all with one another.

The tendency of researchers to be "creative" both in defining and developing measures of locus of control has made the task of generalizing findings across studies more difficult (see Furnham and Steele, 1993; Skinner, 1996). Some studies have used locus of control scales with so little evidence of construct validity that it is unclear what they are actually measuring. It is a tribute to the strength and viability of the locus of control construct itself that, in spite of the differences in definition and inconsistencies in measurement, findings have been replicated across an impressive collection of psychological and physical outcomes.

A complete review of locus of control findings is beyond the scope of the present paper. Suffice it to say that locus of control has been found to be associated with achievement, be it in *academia* (Kalechstein and Nowicki, 1997; Flouri, 2006), *sports* (Morris et al., 1979; Porat et al., 1989; Arnaud and Palazzolo, 2012), or *business* (Spector et al., 2002; Wu et al., 2015) as well as with indicators of *physical health* (Sørlie and Sexton, 2003; Sturmer et al., 2006; Chipperfield et al., 2016) and *psychological adjustment* (Harrow et al., 2009; Cheng et al., 2013). (For other reviews of locus of control findings see Lefcourt, 1982, 1983; Kormanik and Rocco, 2009; Nowicki, 2016a).

Parent Locus of Control

In spite of its obvious importance, few of the many thousands of locus of control studies have directly investigated the association between parent locus of control and child outcomes. Unfortunately, the studies that have been completed are characterized by the application of cross-sectional methodologies, small numbers of participants, an emphasis on mothers' not fathers' locus of control, and an unfortunate propensity to measure locus of control in a variety of ways.

The most frequently used measure in this area of work is the Parent Locus of Control scale (Campis et al., 1986) but most often researchers pick out different subscales as their measure (e.g., total score, parent control, or parent efficacy scales). Two studies (Ollendick, 1979; Hoza et al., 2000) chose global locus of control scales and another provided a "new" test of locus of control but did not provide evidence of convergent or discriminative validity or reliability (e.g., Becker et al., 2010).

Another shortcoming in the research conducted regarding the association of parent locus of control and child outcomes is that researchers studied samples of children that varied widely in age. For example, Becker et al. (2010) included children between 6 and 14; Campis et al. (1986) used "elementary" school age children; Janssens (1994) studied children between 9 and 12 and McElroy and Rodriguez (2008) used children between 5 and 12. Preschool children constituted the most homogeneous age population studied (e.g., Estroff et al., 1994; Coyne and Thompson, 2011).

In spite of the limitations of these studies one consistent result was found; externality in one or both parents was associated with more negative outcomes in their children, whether the outcomes were measured in preschool (e.g., Estroff et al., 1994), or preadolescent and adolescent participants (e.g., Freed and Tompson, 2011), or by diagnoses like Attention Deficit/Hyperactivity (Hoza et al., 2000), or anxiety (Becker et al., 2010).

Three studies deserve additional mention. Two because they examined the impact of parent locus of control on children's behavior over time and one because it assessed both parents' global locus of control and used a system of combining their scores that made it easier to evaluate the contribution of each parents' orientation to their children's outcomes.

First, Moreland et al. (2016) examined outcomes in preschool children as a function of parent locus of control (as measured by the specific parental control subscale of the overall Parental Locus of Control scale) in both mothers and fathers. The authors were interested in determining if a parenting intervention would have a beneficial impact on both the stress level and locus of control of parents along with concomitant positive change in their children's behavior. Before the intervention, externality in mothers, and fathers was related to greater disruptive behavior and lower cognitive coping in children. However, the successful intervention lowered parental stress and made them more internal, children's disruptive behavior decreased and their coping skills increased. These findings suggest that interventions making parents more internal may also increase the likelihood that children's behavior will improve.

Second, while Hagekull et al. (2001) did not include an intervention, they did complete a long term prospective study on parent locus of control. They used two of the five subscales of the Parental Locus of Control scale (parental control and parent responsibility). Both subscales were completed when children were 33 months old and again when they were 9 years old. The researchers found that externality as measured on the parental control subscale for mothers and fathers was uniquely related to greater child difficulties both concurrently and prospectively. They concluded that "the results of the present study point to parents' perceived control as important for their children's development of externalizing and internalizing problems as well as for social and non-social competence development."(p. 436). They went on to suggest that parent control perceptions had an independent impact on development during the preschool years over and above infant temperament and acting out behavior.

Although Ollendick (1979) did not include an intervention or use a prospective design, he did administer age appropriate forms of the same generalized locus of control scale to parents

(Adult Nowicki Strickland Internal-External control scale, Nowicki and Duke, 1974) and children (Children's Nowicki Strickland Internal External control scale. Nowicki and Strickland, 1973). He then organized them into different combinations based on their locus of control scores: Mother and father both internal, mother internal-father external, father internal-mother external, and mother and father both external. Forming these combinations allowed him to evaluate the input of locus of control orientation for each parent on their child's behavior. He concluded that "children who have both external locus of control parents were significantly more anxious than other children who had at least one, or both internal locus of control parents. These results indicate the benefits of children having at least one internally controlled parent. It would seem most plausible that external locus of control parents are those who are the most inconsistent in their parenting attempts. The ill-effects of inconsistent parenting on children has been described by Lefcourt (1976)."

The Present Study

Based on the definition of locus of control offered by Rotter (1954, 1966, 1975, 1990) and explicated by Lefcourt (1976, 1981, 1982, 1983), characteristics associated with internality should lead internals to be better parents than externals. Internals are theorized to be more responsible and persistent, more able to delay gratification and better able to gather relevant information than externals, all of which are advantageous for effective parenting. As mentioned earlier, research results confirm that, generally, internals achieve more, are better adjusted and more successful than externals.

Research on the parent locus of control, child outcome findings have supported theoretical assumptions; external parents have children who are more likely to have negative personality and behavioral outcomes than offspring of internal parents. However, previous findings were based on studies that failed to use prospective methodologies, representative populations of participants, reliable locus of control scales consistent with Rotter's definition and rarely included the locus of control of both parents.

The present study sought to remedy these shortcomings by using a prospective design with a large representative sample including both fathers and mothers, and a well-accepted Anglicized form of the Adult Nowicki Strickland scale to measure locus of control. In addition, because of the unique advantage of having both father's and mother's prenatal locus of control scores, four combinations of parent locus control could be formed identical to those used successfully by Ollendick (1979): Mother and father both internal, mother internal father external, mother external father internal, and mother and father both external. Based on social learning theory and past empirical research it was predicted that parents who were both internal would produce more positive child outcomes than parents who were both external.

More specifically the following predictions were made.

(1) During pregnancy parents who are both internal compared to those who are both external would be more prone to seek out information about pregnancy and birthing and as a result be more likely to participate in "preparation" classes about giving birth.
(2) Because parents who are both internal will be more organized, persistent and responsible than parents who are both external, they will be more prepared to solve the problems presented by their children's sleeping, eating, and tantrum behaviors and thus will have fewer difficulties in these areas.
(3) In the parental pairing where one parent is internal and the other external, we suggest, consistent with what Ollendick found, that the presence of internality in at least one parent, especially the mother, will produce more positive outcomes when compared with both parents being external.
(4) Because past research results have been mixed as to whether mothers' or fathers' locus of control differentially affect sons' and daughters' outcomes, we analyzed the data separately for boys and girls, without making predictions based on gender.

MATERIALS AND METHODS

Participants

The ALSPAC pre-birth cohort was designed to determine the environmental and genetic factors that are associated with health and development of the study offspring (Golding and the ALSPAC Study Team, 2004; Fraser et al., 2013). As part of the study design, therefore, there was a concerted effort before the child's birth to obtain from the parents details of their personalities, moods and attitudes, including a measure of their LOC.

ALSPAC recruited 14,541 pregnant women resident in Avon, UK with expected dates of delivery between 1st April 1991 and 31st December 1992 (an estimated 80% of the eligible population). Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, and linkage to other data sets. The ALSPAC Ethics and Law Advisory Committee agreed that consent was implied if questionnaires were returned. Informed written consent was obtained for all biological samples prior to analysis, and for certain invasive procedures during the hands-on assessments (which were optional to attend).

With the advice of the ALSPAC Ethics and Law Advisory Committee it was decided not to enroll the study fathers directly, but rather to send to the mother a questionnaire for her partner and ask her if she would like her partner to be involved, and if so whether she would be good enough to pass the questionnaire to him (or her) with a separate reply-paid envelope for return. The study deliberately had no information on whether the mother had invited her partner to take part except when the completed questionnaire was returned. It should be noted that in consequence of this format, there was no way in which the study could send reminders to the partner themselves; during pregnancy questionnaires were returned by 76% of the partners of women who were taking part in the study.

For this project we have concentrated on the data collected from 9 questionnaires completed before and after the birth of the study child by the mother, and for the partner the questionnaire sent in pregnancy that included the LOC scale. The post-delivery questionnaires completed by the mother concerned the behavior

of the child between 6 and 57 months post-delivery. The 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/.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

Measures

Locus of Control

The Adult Nowicki Strickland Internal External control scale (ANSIE, Nowicki and Duke, 1974) followed Rotter's definition in its construction. It has an easier reading level than the Rotter scale, but is significantly correlated with Rotter's test (Nowicki, 2016a) making it appropriate for testing adults from the general community.

An Anglicized and briefer form of the ANSIE was used in the present study. It contained the 12 items from the original 40 item scale which possessed the highest item-total correlations based on the responses of 135 mothers. Factor analysis of responses from 12,471 women confirmed the single factor structure of the scale. Coefficient alpha was 0.78 in this population. The scores ranged from 0 to 12 and were normally distributed with medians of 4 and 3 for the mothers ($n = 12{,}471$) and their partners ($n = 8{,}645$) respectively. The higher the score the more external the locus of control. For the present study external locus of control was defined as above the median while internal locus of control was defined as scores equal to or lower than the median.

Parental Preparations and Actions

There were six variables that we have used to describe the efficiencies of the parents during pregnancy and subsequently. Each, if carried out, has health benefits for the child. (i) During the pregnancy the mother was asked the date of her last menstrual period (LMP), and whether she was certain of this. From this the variable "uncertain of LMP" was derived to include those women who did not know their dates at all. After delivery the mother was asked (ii) whether she had attended labor and/or parentcraft classes during pregnancy; (iii) whether her partner had accompanied her; (iv) whether the father was present at delivery; (v) whether the child was breast fed; and (vi) whether the child had received the full set of early immunizations recommended.

Sleeping Behavior

Sleeping behavior of the child was measured using a number of questions repeated in different questionnaires which the mothers completed at their leisure at home. The questions were phrased as follows: "In the past year has your child regularly (a) refused to go to bed; (b) got up after only a few hours' sleep?" In addition they were asked: "Does your child have a regular sleeping routine (i.e., does he/she tend to go to sleep at the same time every day)?" These questions were asked at ages 18, 30, 42, and 57 months of age.

Feeding Behaviors

Feeding behaviors were elicited from the mothers with items used in the 1970 British birth cohort. They included the following questions in relation to the past year: (i) whether the mother found it difficult to establish an eating routine (asked at 24, 38, and 54 months), (ii) whether the child had over-eaten, and (iii) whether the child was choosy with food (15, 24, 38, and 54 months). At 57 months the mother was asked how much choice the child was allowed in regard to the main meal of the day, with three options for response: "from any available foods"; "from a few alternatives"; or "an adult decides." She was also asked a similar question in regard to choice of snacks.

Temper Tantrums

Temper tantrums were a focus of attention in questionnaires at 18, 30, and 42 months. When these occurred mothers were asked how often they reacted in particular ways (she ignored the child, tried to cuddle the child, reasoned with the child or tried to distract the child) with possible answers often; sometimes; never. When the child was 24 months old the mother was also asked how often she smacked the child, and/or shouted at the child when he/she was having a tantrum.

Statistical Approach

There is a considerable literature describing ways in which the child's adverse behavior is associated with maternal youth, low levels of education as well as exposure to prenatal smoking. These factors may also be a consequence of external LOC orientation—i.e., be on the causal pathway. Consequently analysis taking these three factors into account is likely to be misleading. We have therefore presented the data as unadjusted in order to demonstrate a pattern of associations.

For each child and parental outcome a comparison was made between maternal external and internal locus of control individuals, as well as between the paternal external and internal individuals. The comparisons of proportions with the outcome in each group used unadjusted chi-squared analyses and presented the results as odds ratios with 95% confidence intervals. These are all shown in the Supplementary Tables. For analyses assessing the differences within families, the proportion of each outcome is compared within the type of orientation of the mother. Thus, External mothers were selected and comparisons made between the outcomes according to the orientation of her partner; separately Internal mothers were selected and comparison of outcomes made between those whose partners were external and internal. For space reasons we did not present the odds ratios and confidence limits in these tables; the data are provided from which the interested reader can calculate these statistics if required.

The analyses were carried out for all children and, although we stratified by sex of the child, the results did not differ and have therefore been omitted from this paper.

RESULTS

Parental Preparations and Actions

A comparison of externally and internally oriented mothers shows that those who were externally controlled were less likely to know the date of their LMP, less likely to attend parenting classes, less likely to breast feed and less likely to ensure their child was fully immunized by 6 months of age. Similar relationships for

TABLE 1 | The proportions (%) of parents who failed to undertake recommended health behaviors according to the LOC orientation of the pair.

Behavior	*N*	M.E+F.E %	M.E+F.I %	*P*	*N*	M.I+F.E %	M.I+F.I %	*P*
Mother uncertain of her LMP	3,521	19.6	14.6	<0.001	4,984	20.5	9.6	<0.0001
Mother did not attend classes	3,288	42.7	39.1	0.044	4,680	37.1	31.7	<0.001
Father did not attend classes	3,275	77.4	71.1	<0.0001	4,660	70.4	60.4	<0.0001
Father not at delivery	3,302	14.7	12.2	0.038	4,688	9.8	7.3	0.002
Child not breast fed	3,407	34.9	24.3	<0.0001	4,773	20.1	10.1	<0.0001
6 months child not fully immunized	3195	16.9	11.8	<0.0001	4,646	10.0	7.4	0.002

M.E, Mother external; M.I, Mother internal; F.E, Father external; F.I, Father internal; LMP, date of last menstrual period.

TABLE 2 | Percentage of parents who have sleeping problems with their child according to the locus of control orientation of both parents.

Age	*N*	M.E+ F.E %	M.E+F.I %	*P*	*N*	M.I+F.E %	M.I+F.I %	*P*
NO REGULAR ROUTINE								
18 months	3,056	17.5	13.0	<0.001	4,536	13.5	9.3	<0.0001
30 months	2,855	16.0	12.4	0.007	4,282	10.0	6.8	<0.001
42 months	2,760	12.0	8.8	0.007	4,217	6.0	4.4	0.018
57 months	2,610	8.5	6.9	0.138	4,043	4.2	2.9	0.037
REFUSAL TO GO TO BED								
18 months	3,061	29.8	27.0	0.086	4,525	24.5	20.2	<0.001
30 months	2,846	55.4	47.5	<0.0001	4,280	44.0	36.1	<0.0001
42 months	2,783	51.8	44.3	<0.001	4,246	40.6	31.8	<0.0001
57 months	2,609	50.1	41.0	<0.0001	4,040	35.6	29.2	<0.0001
GETS UP AFTER ONLY A FEW HOURS OF SLEEP								
18 months	3,061	26.4	21.8	0.003	4,525	19.5	15.2	<0.001
30 months	2,824	27.6	25.3	0.188	4,261	21.2	16.1	<0.0001
42 months	2,783	21.8	19.1	0.087	4,246	16.4	11.6	<0.0001
57 months	2,602	15.5	12.8	0.050	4,024	12.2	8.1	<0.0001

M.E, Mother external; M.I, Mother internal; F.E, Father external; F.I, Father internal.

fathers with an external LOC were found to be associated with paternal failure to accompany the mother to classes or be present at delivery (Table S1).

An examination of the relationships when both parents were considered together (**Table 1**) showed that if the woman was externally oriented, the internal orientation of her partner appeared to have a beneficial effect on the mothers' knowledge of her LMP, whether the child was breast fed or fully immunized. If, however the mother was internally oriented, when compared with having an internal partner having an external partner appeared to result in more uncertainty about her LMP, being less likely to attend parenting classes, breast feed or ensure the child was fully immunized. The attendance of the father at classes, and (to a lesser extent) at delivery appears to have depended on the orientation of both parents, and was particularly likely if both were internal compared with both external.

Sleeping

There are a variety of measures of the child's sleep behavior in the first 5 years of life, and we concentrate on the answers to three different questions answered by the mother at four different time points (18, 30, 42, and 57 months).

Children with No Regular Sleeping Routine

The proportion of children without a regular sleeping routine gradually reduced between 18 and 57 months, but was always greater if the mother or the father was externally oriented (Table S2). In **Table 2** we compare the responses of the four different combinations of parent locus of control: Both external (M.Ext+F.Ext), with mother external, father internal (M.Ext+F.Int), and mother internal, father external (M.Int+F.Ext), with both internal (M.Int+F.Int). It can be seen that: (i) if the mother is external, the proportion of children without a regular sleep pattern reduces if the father is internal; (ii) conversely if the mother is internal the proportion without a regular sleep pattern is greater if the father is external rather than internal; (iii) If both parents are external the risk of failure to have a regular sleep pattern is far greater than if both parents are internal—the ratio of the proportion of external to internal pairs is 1.88, 2.35, 2.73, and 2.93 for the ages 18, 30, 42, and 57 months respectively; (iv) for children who have one internal and one external parent the risk of failing to have a regular sleeping routine is greater for those for whom the mother is external, especially when aged over 18 months.

Refusal to Go to Bed

As with failure to have a regular sleeping routine, the proportion of children who refused to go to bed was higher if either parent had an external rather than an internal orientation (Table S3); this was true for both boys and girls. Comparison within the four combinations of parental locus of control (**Table 2**) shows a similar pattern to that found for a lack of a sleeping routine: (i) if the mother is external, the proportion of children refusing to go to bed reduces if the father is internal; (ii) conversely if the mother is internal the proportion refusing to go to bed is greater if the father is external rather than internal; (iii) If both parents are external the risk of failure to have a regular sleep pattern is far greater than if both parents are internal—the ratio of the proportion of external to internal pairs is 1.48, 1.53, 1.63, and 1.72 for the ages 18, 30, 42, and 57 months respectively; (iv) for children who have one internal and one external parent the risk of failing to have a regular sleeping routine is greater for those for whom the mother is external.

Gets Up after Only a Few Hours of Sleep

In regard to getting up after a few hours' sleep the pattern is similar in that this is more likely to occur if the parent is external (Table S4). A study of the relationships with the LOC orientation of the two parents also shows a slightly different pattern to that found for the sleeping characteristics shown above. In **Table 2** the rates of getting up after going to sleep indicate, once again, that if the mother is external, having an internal partner is associated with a reduced rate of this characteristic, but the relationships are significant in only one of the four ages. However if the mother is internal there is a more significant difference in this sleep pattern if her partner is external. Again the rate of getting up after only a few hours of sleep is much greater if both parents are external, compared to parents who are both internal, with ratios of 1.74, 1.71, 1.88, and 1.91; when there is a combination of externality/internality in the parents, the child will generally be slightly more likely to get up after a few hours of sleep if the father is internal.

Feeding

Characteristics of the child's eating behavior were asked of the mother at 15, 24, 38, and 54 months post-delivery. Here we concentrate on three of these—the mothers' failure to establish an eating routine (unfortunately not asked at 15 months), the child perceived to have over-eaten and the child being choosy with food. The latter was chosen as it exhibits a reverse association with parental LOC orientation.

Mother Finds It Difficult to Establish an Eating Routine

Difficulties with establishing a routine were greatest when the child was 38 months old, but at each age the difficulties were slightly greater if the parent was external (Table S5). Comparison of the four combinations of parents differing in locus of control, however, (**Table 3**) indicates that it is the mother's LOC that is important, and that of her partner appears to have no effect in this regard.

Child Overeats

The mother was asked on four occasions whether the child had had episodes of overeating in the past year. On each occasion the children with an external parent were more likely to be reported as over-eating (Table S6). In **Table 3** we compare the four different combinations of parent locus of control. It can be seen that: (i) if the mother is external, the proportion of children who overeat reduces slightly but not significantly (except at 54 months) if the father is internal, (ii) conversely if the mother is internal the proportion of children that overeat is significantly greater if the father is external rather than internal, (iii) If both parents are external the risk of the child overeating is greater than if both parents are internal—the ratio of the proportion

TABLE 3 | Percentage of parents who have feeding problems with their child according to the locus of control orientation of both parents.

Age	*N*	M.E.+F.E %	M.E.+F.I %	*P*	*N*	M.I.+F.E %	M.I.+F.I %	*P*
NO ESTABLISHED ROUTINE								
24 months	2,887	23.0	23.1	0.956	4,365	20.8	20.6	0.864
38 months	2,803	28.2	26.0	0.182	4,272	24.3	23.5	0.585
54 months	2,662	23.9	22.0	0.257	4,049	18.0	17.4	0.650
CHILD OVEREATS								
15 months	3,075	22.5	20.2	0.133	4,521	21.1	16.9	<0.001
24 months	2,887	18.3	17.2	0.440	4,365	17.5	13.7	<0.001
38 months	2,803	15.8	14.0	0.197	4,272	15.3	12.0	0.003
54 months	2,668	21.1	17.2	0.013	4,054	16.3	14.1	0.054
CHILD IS CHOOSY WITH FOOD								
15 months	3,075	51.2	53.4	0.234	4,521	56.6	58.6	0.186
24 months	2,887	65.4	66.8	0.435	4,365	68.0	71.3	0.025
38 months	2,803	70.2	71.5	0.490	4,272	75.1	74.2	0.521
54 months	2,678	77.8	79.0	0.437	4,069	79.2	80.2	0.441

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

of external to internal pairs is 1.33, 1.34, 1.32, and 1.50 for the ages 15, 24, 38, and 54 months respectively, (iv) for children who have one internal and one external parent the risk of overeating is similar regardless of which parent is external.

Child Has Been Choosy with Food

Being choosy with food, also known as "picky eating" is common but can cause a great deal of stress to parents, and tends to develop into a habit that continues through childhood and beyond (e.g., Dovey et al., 2008; Taylor et al., 2015). At all ages the rate of this characteristic is lower if the mother is external although this pattern is much less apparent in relation to the father's orientation (Table S7). A comparison of rates of childhood choosiness within a family (**Table 3**) shows no consistent differences among external mothers if the father is internal, nor any difference among internal mothers if the father is external. Thus, the evidence suggests that it is only the mother's locus of control orientation and not the father's that is related to "choosiness," and that unlike other types of feeding difficulties, it is the children of external mothers that have fewer problem behaviors.

In an attempt to investigate the reasons for these differences we compare the attitudes of the external and internal mothers and their partners in regard to allowing the child to choose what to eat. This indicates that the external mother is much more likely to allow a wide choice both of main meal and snacks compared to the mother with an internal LOC (Tables S8, S9). Comparison of the four different combinations of parent locus of control (**Table 4**) indicates that (i) if the mother is external she is less likely to allow choice of main meal from available foods if her partner is internal; (ii) she is also less likely to allow choice of all available snacks if her partner is internal; (iii) however if she is internally oriented the child is significantly more likely to be allowed to choose freely if the father is external; (iv) The child's ability to have a free choice of foods is greatest if both parents are external (19.7 and 51.4% for main meal and snacks respectively) and least if both are internal (8.8 and 30.2%); (v) if the partners are of mixed locus of control orientation, those with an external mother are more likely than those with an external father to allow free choice of main meal.

TABLE 4 | The choices presented to the child for the main meal and for snacks at 57 months according to the LOC orientation of the parents.

Choice	M.E+F.E %	M.E+F.I %	*P* (*N*)	M.I+F.E %	M.I+F.I %	*P* (*N*)
MAIN MEAL						
From any available foods	19.7	16.6		11.4	8.8	
From a few alternatives	47.1	43.9		52.3	50.7	
Adult decides	33.3	39.5		36.3	40.6	
			0.001 (2562)			0.001 (3986)
SNACKS						
From any available snacks	51.4	42.4		39.6	30.2	
From a few alternatives	39.8	48.3		53.6	60.8	
Adult decides	8.8	9.3		6.8	9.1	
			<0.001 (2510)			<0.0001 (3924)

M.E, Mother external; M.I, Mother internal; F.E, Father external; F.I, Father internal.

Temper Tantrums

Prevalence of Temper Tantrums

The study mothers were asked whether their child had temper tantrums. **Table 5** indicates that there is very little difference in the prevalence of tantrums between the children of mothers or fathers relative to their LOC orientation, although the proportion was always slightly higher for the children of externally orientated parents.

Actions of the Mother When the Child Has a Temper Tantrum

Mothers were asked the same four questions at three time points (18, 30, and 42 months) concerning how they reacted when the child had a tantrum: (i) whether they ignored it; (ii) whether they cuddled the child; (iii) whether they tried to reason with the child; and (iv) whether they tried to distract the child. For each item they were given the options: Yes often; yes sometimes, and never.

Mothers Ignore Temper Tantrum

The greater the presence of parent externality rather than internality the more likely it was that the mother would ignore the tantrum (Table S10). When the pair of parents were considered together there was little evidence that the study father had an influence on this behavior which was dominated by the mothers' externality (**Table 6**).

Mother Cuddles the Child during Temper Tantrum

There were consistent findings at each age such that externally oriented parents were more likely to state that they never cuddled the child when he/she was having a tantrum (Table S11). Results for the mother-father partnerships (**Table 7**) indicate that if the mother is external, having an internal partner makes a difference in that she is more likely to cuddle the child at least sometimes (74.0 vs. 69.6; 78.4 vs. 76.2; 70.1 vs. 65.6 for the three ages); if the mother is internal there is a similar but more marked contrast between her behavior when the fathers are external and internal (75.0 vs. 78.1; 78.6 vs. 81.8; 70.2 vs. 74.4).

TABLE 5 | Proportion of children reported to have temper tantrums according to whether the parent was externally or internally oriented in pregnancy.

Age	N.Mother	M.E %	M.I %	N.FATHER	F.E %	F.I %
18 months	10,571	89.2	87.5	7,590	89.4	86.4
30 months	9,892	89.2	88.8	7,163	88.8	88.4
42 months	9,610	84.0	81.8	6,994	83.6	81.7
57 months	9,146	76.6	72.4	6,690	74.9	72.6

M.E, Mother external; M.I, Mother internal; F.E, Father external; F.I, Father internal.

Mother Reasons with the Child Having a Temper Tantrum

In contrast with the other associations with behavior of the mother when the child is having a tantrum, there were no differences between the LOC orientation of either parent in regard to the mother trying to reason with the child (Table S12). Similarly there was no indication that the mother's behavior differed with the orientation of her partner (**Table 8**).

Mother Tries to Distract the Child during Temper Tantrum

The frequency with which the mother tried to distract the child during a tantrum was strongly associated with the LOC orientation of each parent, with the children of internal parents being more likely to experience this often, and the children of external parents being at increased risk of never experiencing this (Table S13). This pattern was highly significant.

When the partnerships were analyzed (**Table 9**) it can be seen that the greatest rate of maternal distraction of the child was when both parents were internal compared with both being external (54.7 vs. 38.1% at 18 months; 42.9 vs. 33.6% at 30 months; and 31.5 vs. 25.3% at 42 months). Conversely the parents who are both external compared with those who are both internal have greater associations with the mother never trying to distract the child (14.1 vs. 5.6%; 10.4 vs. 4.3; 18.7 vs. 11.2%). Where the two partners are of different orientations there is some indication that the maternal orientation is more important, but this is not consistent at each age.

Mother Smacks and/or Shouts at Child

Only at one age (18 months) was the mother asked how often she smacked the child when he/she was having a tantrum. The mother was more likely to smack the child if she was external rather than internal. A similar pattern was shown for the orientation of the father (Table S14). Comparison of the mothers' actions depending on the orientation of the father indicates that

TABLE 6 | Frequency with which parents ignore temper tantrum.

	M.E.+F.E %	M.E.+F.I %	*P* (*n*)	M.I.+F.E %	M.I.+F.I %	*P* (*n*)
AT 18 MONTHS						
Often	50.5	50.4		47.1	45.4	
Sometimes	44.2	42.9		44.8	45.9	
Never	5.3	6.7		8.0	8.7	
			0.499 (2711)			0.260 (3927)
AT 30 MONTHS						
Often	44.8	43.5		42.9	37.5	
Sometimes	51.6	51.6		51.5	56.2	
Never	3.6	4.8		5.6	6.3	
			0.271 (2487)			0.003 (3719)
AT 42 MONTHS						
Often	38.5	35.1		33.5	30.8	
Sometimes	52.9	54.8		56.9	59.1	
Never	8.6	10.1		9.6	10.1	
			0.060 (2325)			0.134 (3437)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

TABLE 7 | Frequency with which child was cuddled during temper tantrum, comparing the orientation of each parent.

Frequency	M.E+F.E %	M.E+F.I %	*P* (*n*)	M.I+F.E %	M.I+F.I %	*P* (*n*)
AT 18 MONTHS						
Often	15.1	16.8		16.5	19.8	
Sometimes	54.6	57.2		58.5	58.3	
Never	30.4	26.0		25.0	21.9	
			0.018 (2711)			0.003 (3927)
AT 30 MONTHS						
Often	16.5	17.4		16.3	18.0	
Sometimes	59.6	61.0		62.3	63.8	
Never	23.8	21.6		21.4	18.2	
			0.225 (2427)			0.020 (3639)
AT 42 MONTHS						
Often	12.1	12.3		12.3	13.5	
Sometimes	53.5	57.8		57.9	60.9	
Never	34.4	29.9		29.8	25.6	
			0.084 (2325)			0.016 (3437)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

TABLE 8 | Frequency with which mother reasons with the child while having a temper tantrum.

Frequency	M.E+F.E %	M.E+F.I %	*P* (*n*)	M.I+F.E %	M.I+F.I %	*P* (*n*)
AT 18 MONTHS						
Often	20.8	22.6		23.6	20.6	
Sometimes	56.1	51.5		54.0	54.8	
Never	23.1	25.9		22.4	24.5	
			0.710 (2711)			0.025 (3927)
AT 30 MONTHS						
Often	33.1	33.4		35.0	33.1	
Sometimes	59.0	59.7		58.1	59.3	
Never	7.9	6.9		7.0	7.6	
			0.590 (2441)			0.218 (3685)
AT 42 MONTHS						
Often	35.8	36.0		38.3	35.1	
Sometimes	53.8	55.9		53.2	56.4	
Never	10.4	8.1		8.5	8.6	
			0.334 (2325)			0.119 (3437)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

there was no difference if the mother was external, but if she was internal, her partner's external orientation appears to have an influence such that she was more likely to slap the child (**Table 10**). The analyses for the mother shouting at the child were similar to those found for slapping (Table S15 and **Table 11**).

TABLE 9 | Frequency with which mother tries to distract the child during temper tantrum according to the orientation of each of the parents.

Frequency	M.E+F.E %	M.E+F.I %	*P* (*n*)	M.I+F.E %	M.I+F.I %	*P* (*n*)
AT 18 MONTHS						
Often	38.1	44.6		50.5	54.7	
Sometimes	47.8	45.7		41.4	39.7	
Never	14.1	9.7		8.2	5.6	
			<0.0001 (2711)			<0.001 (3927)
AT 30 MONTHS						
Often	33.6	39.8		40.5	42.9	
Sometimes	56.0	52.5		51.8	52.8	
Never	10.4	7.7		7.7	4.3	
			<0.001 (2247)			0.004 (3715)
AT 42 MONTHS						
Often	25.3	26.1		30.1	31.5	
Sometimes	56.0	58.5		55.3	57.3	
Never	18.7	15.4		14.5	11.2	
			0.140 (2325)			0.034 (3437)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

TABLE 10 | Frequency mother smacks the child when having a tantrum (18 months).

Frequency	M.E+F.E %	M.E+F.I %	*P* (*n*)	M.I+F.E %	M.I+F.I %	*P* (*n*)
Often	1.2	0.6		0.8	0.3	
Sometimes	25.8	26.3		22.4	18.4	
Never	73.0	73.1		76.8	81.2	
			0.709 (2711)			<0.001 (3927)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

TABLE 11 | Frequency mother shouts at the child when having a tantrum (18 months).

Frequency	M.E+F.E %	M.E+F.I %	*P* (*n*)	M.I+F.E %	M.I+F.I %	*P* (*n*)
Often	4.4	3.9		3.4	1.9	
Sometimes	59.2	60.3		53.8	50.8	
Never	36.4	35.8		42.7	47.2	
			0.984 (2711)			<0.001 (3927)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

Frequency of Temper Tantrums at 57 Months

We have assessed the frequency with which children are having temper tantrums prior to reaching age 5, primarily to determine whether there were still differences between the children of external and internal parents. The children of mothers who were externally oriented were more likely to have temper tantrums, and to have them more frequently, than children of internally oriented women (**Table 12**). A similar pattern was shown with the orientation of the father. In general a comparison of the children of externally oriented women with external partners and internal partners showed only a small difference in frequency ($P = 0.021$); similarly among women who were internal, there was only a small difference associated with the father's orientation ($P = 0.024$).

DISCUSSION

Being a parent is a most complex and demanding task. Children present a never ending progression of behavioral challenges for parents and how these demands are met determines their physical, psychological, and emotional development. The present study looked at some of the most important and complex parenting tasks to see how parents' locus of control appeared to influence children's responses. Developmental situations are complex and no single parental response will always be the best, but some responses are better than others for children over the long term. From what is known about locus of control, parental internality was expected to be associated with positive child outcomes more often than parental externality.

TABLE 12 | Frequency with which child was having temper tantrums at 57 months.

Frequency	M.E+F.E %	M.E+F.I %	OR[95%CI]	M.I+F.E %	M.I+F.I %	OR[95%CI]
1+ per day	3.1	1.9	1.76 [1.04, 2.99]	1.9	1.3	1.54 [0.91, 2.58]
Most days	15.5	12.1	1.40 [1.09, 1.79]	9.6	8.6	1.13 [0.90, 1.43]
1+ per week	22.1	23.0	1.05 [0.85, 1.29]	20.8	19.3	1.10 [0.92, 1.31]
<1 per week	35.5	38.8	1.00 Ref	41.1	42.0	1.00 Ref
Not at all	23.8	24.2	1.08 [0.88, 1.32]	26.7	28.7	0.95 [0.81, 1.11]
			$P = 0.021$ ($n = 2616$)			$P = 0.024$ ($n = 4058$)

M.E, Mother External; M.I, Mother Internal; F.E, Father External; F.I, Father Internal.

The results of this study reveal that internal and external parents approach the future birth of their child and his or her development in significantly different ways. From attitudes and beliefs expressed prenatally and on most indices of children's behavior and personality through infancy and toddlerhood, children of internal parents behaved differently from those of external parents. Overall the differences suggest internal as compared to external parents are more involved in acquiring relevant information about parenting skills and more organized and consistent in interactions with their children.

Prenatal Attitudes and Behavior

Even before the baby is born, internal parents are more involved in finding out relevant parenting information than are external caretakers. For example, they were more likely to attend child preparation classes and their partners were more likely to accompany and to be present during labor and delivery than external parents-to-be. Internal as opposed to external mothers are more likely to know the date of their last menstrual period and to ensure their child is immunized by the age of 6 months. These behaviors are consistent with what is theoretically expected from internals (Rotter, 1966); that is, they, as internal parents, are more likely to seek out more information about the birth experience and subsequent child care than their external peers.

The core set of prenatal expectations held by internal parents and the information they gathered beforehand suggest that they also are better prepared for the arrival of the infant than external caretakers. Such preparation also indicates that they also may be more adept at dealing with future challenges presented by their children's sleeping, eating, and tantrum behaviors than external parents.

One early indication of this comes from the finding that internal as contrasted with external parents report being more willing to give their 4 week old babies "a cuddle" when they wake up at night. The act is consistent with the prenatal attitude of internal parents in which they stated they were more likely to adapt their lives to accommodate their new born than externals (data not shown).

Sleeping Behavior

Although we do not know all of the possible reasons for it, bed times are more problematic situations for children of external compared to internal parents. External parents appear less able to organize their children's lives and be consistent about procedures surrounding bedtime than internal caretakers. While we do not know what contributes to this outcome, we do know from past research with adults, that externals are less persistent and structured than internals (Nowicki, 2016b). If that is also true of their parenting behavior, then external parents may be less able to behave and parent consistently which, in turn, is more likely to create a confusing and unpredictable environment for their children, thus increasing chances for them to behave more negatively at bedtime.

Feeding

A similar pattern of behavior surrounded the family's eating behavior as it had with sleeping situations. Externally controlled parents, especially externally controlled mothers, report a more difficult time establishing a family eating routine than their internal counterparts. Unsettled meal times may add to or perhaps cause the unsettled behaviors that seemed to surround and characterize bedtime for children of external mothers and fathers. With this in mind, it is not surprising that within this mealtime turmoil, children of external parents may eat more than they should. External parents compared to internal ones, are less likely to see the connection between their children's eating behavior and healthy outcomes and so they may also be less likely to monitor what and how much children are eating. Additional research that actually observes mealtime and bedtime situations is needed to establish exactly what transpires between parents and their children during these situations.

However, the data do reveal that children show markedly different patterns of association between the indicators of eating behavior and parent combination of locus of control. These can be summarized as follows: (i) difficulty in establishing an eating routine was governed primarily by the orientation of the mother, being higher if the mother was external; (ii) overeating was most prevalent if both parents were external; the greatest differences were found between them and both parents who were internal; (iii) if the mother was external the orientation of the father made little difference, however if the mother was internal the orientation of her partner significantly affected the eating behavior; (iv) children's choosiness about what to eat was most prevalent if the mother was internal; the orientation of her partner made little difference in this behavior; the evidence suggested that the externally oriented mothers had a laissez faire attitude to what their children ate, resulting in a lower prevalence of picky eating.

The fact that internal parents, especially mothers, reported their children as being "more choosy" about the food they ate deserves some comment. This could be a negative feature of being a child of internal parents in the sense that it reflects being "spoiled" or "catered too." However, experts in the "picky eating" field show that insistence of parents in trying to guide their child to eat foods they do not like results in some adverse nutritional consequences and even increased prevalence of constipation (Taylor et al., 2016). Additional observational research focusing on exactly what and how the children of internal parents are offered food compared to children of external parents is necessary to resolve the possible explanations offered or to come up with new ones.

Temper Tantrums

The unpredictability and chaos that surrounds sleeping and eating routines is also present in how internal and external parents deal with their children's tantrums. Tantrums are a difficult problem for all parents, especially as children grow older. Often there is a public aspect to the tantrums that increases their impact; children's crying and screaming often draws the unwanted attention and scrutiny of others. From our data analysis it is apparent that regardless of locus of control orientation all parents have to face the stress of dealing with their children's tantrums and are equally prone to try to use "reasoning" to deal with them.

However internal and external parents differ in the use of other interventions to deal with their children's tantrums. For example, at 18 and 30 months of age, external as compared to internal parents are more likely to pay attention to occurrences rather than ignore them, and less likely to "hold/cuddle" their children and/or try to distract them as ways to deal with tantrums. External parents appear to be more likely to distance themselves from their children than their internal peers do and less prone to engage them by the use of soothing or distracting interventions. If this is what is occurring then external parents may be creating a more negative and perhaps even hostile interpersonal situation between them and their children during the tantrum behavior which may increase the intensity of the interaction. Support for this possibility is found in the responses of parents to two additional questions about their reaction to tantrums when their child was 18 months of age. External parents were significantly more likely to "shout at" or "smack/shake" their child during a tantrum than internal parents. The application of such extreme responses does not bode well for quietening the children or improving the parent child relationship. As with sleeping and eating behavior, it would be helpful to have observational data of the ongoing interactions between parents and children to evaluate the quality and the effectiveness of internal and external parents' interventions dealing with tantrums.

To summarize. Temper tantrums are common and are only slightly more prevalent if parents are external. However the behaviors of the mother when her child has a temper tantrum varies in regard to her locus of control and that of her partner in the following ways:

1. The mother ignores the temper tantrum—this behavior was more often found with external mothers. The fathers' locus of control seemed to make no impact.
2. Cuddling the child was less likely to be a strategy if either parent was external.
3. Reasoning with the child was not associated with the locus of control orientation of either parent.
4. Distracting the child was more likely to occur if the parents were internal.
5. Externally oriented mothers are more likely to shout at or smack their child when he or she is having a tantrum. The father's orientation makes little difference to whether the mother shouts at or smacks the child who is having a tantrum if she is external, but it is associated with a difference in such behavior if she is internal.
6. Finally we examine the frequency of having tantrums at 57 months. The children of external mothers had more frequent temper tantrums than the children of internal mothers; the locus of control of the father appeared to make little or no contribution to the occurrence of tantrums.

General Observations

Prenatal parent externality is associated with the consistent parental report of more negative child outcomes than is prenatal parent internality. However the association may be due to external parents having a more negative self-reporting bias than their internal counterparts and it is the bias rather than actual behavioral differences that is responsible for the greater report of problematic child outcomes. One way to evaluate this possibility would be to gather observations of children's behavior from adults other than parents. Teachers are likely candidates. Teacher ratings of children's personality characteristics and psychological functioning are free from the potential negative self-reporting bias of external parents and could provide unbiased evidence of the differential impact of parental locus of control on children's personal and social behavior.

It is apparent that, at the preschool ages focused on in this study, children with externally controlled parents had more difficulty establishing satisfactory eating and sleeping routines compared to their peers with internally controlled parents. Even before the birth of the child, externally controlled parents were less likely to take advantage of programs that could have better prepared them to deal with a new infant, and when an infant arrived they consistently showed that they were less able to organize and direct their children in their everyday activities like sleeping, eating, or loss of temper. This consistent pattern of inconsistent and relatively unstructured parenting surrounding bedtime and meal time may produce children who are less prepared for leaving home to attend full time school. They, both boys and girls with external parents, would be expected to have more problems in school paying attention, following directions, and interacting successfully with others. Future research on children's behavior outside the home when they are older is needed to evaluate this expectation.

How can children of external parents be helped to deal with the lack of structure and consistency they experience? One possibility is by supporting and educating their parents. It is likely that the organizational miscues external parents make may originate from a lack of knowledge of what to expect and what to do when the child arrives in their lives. External parents should be encouraged in every way possible to prepare themselves better for the arrival of their children. External parents may not perceive the connection between what they might learn from prenatal classes and other preparatory experiences that would benefit them in dealing with their child. Because past research shows that externals learn best in structured situations and are especially responsive to primary reinforcement, preparatory programs should be used that take these factors into account.

Besides attempts to improve the child caring knowledge and skill of externally controlled parents, interventions could also focus on directly changing their locus of control orientation toward internality. Some past programs have been marginally successful at changing locus of control in large communities of adults (e.g., Knapp and McClure, 1978), others have been more effective by focusing on changing the language (Roueche and Mink, 1976) or the cognitive thinking (Wolinsky et al., 2010) of individuals. At the same time, it might be useful to apply educational programs that help children become appropriately internal (e.g., Nowicki et al., 2004). Past research has shown that children's internality provides protection from their feelings of helplessness and depression later in childhood. For example Culpin et al. (2015) found that children from impoverished

backgrounds who were at risk for developing depression were able to avoid this outcome if they became internally controlled during their adolescence. Programs instituted to change younger children toward internality may make them more resilient in dealing with negative forces around them.

Strengths and Limitations

The strengths of this project lie in (a) the use of a prospective design; (b) the use of a large and representative population of participants; and (c) the inclusion of both mother's and father's locus of control. This study is the first to examine the associations of parent locus of control and child outcomes over such an extended period of time and provide substantial evidence of the developmental effects of parent internality and externality on children.

Having said that there are a number of limitations. One is that the analyses were restricted to the 80% of the eligible pregnant population that took part in the study. Those who did not take part were biased in that they were likely to be teenagers and/or of low educational achievements (features that have been found associated with externality). However, Fraser et al. (2013) noted that the demographic differences were relatively small.

Another limitation is that the present study was prospective in design, but not a completely longitudinal investigation, since we did not measure parental LOC again during the child's preschool years. It is also possible that as well as parents affecting the children's outcomes, children may have impacted on parents as well. One way to evaluate this possibility also points out another limitation of the present study; there was no direct observation of what went on between parents and children for any of the outcomes. Some studies have directly observed how internal and external parents behaved when interacting with their children (Carton, 1996). The same design could be used to examine the behavior of internal and external parents with their children, especially if both parents were involved in the study.

CONCLUSION

Parental locus of control has much to do with how parents interact with their children. It is clear from the present study that parental locus of control is associated with a number of important parent child interactions surrounding social contact, sleeping, eating, and behavioral regulation. The greater the internality of the parents the better the child outcomes, the greater the externality the worse the child outcomes are in all of these crucial areas except for picky eating in the pre-school child. We suggest that initiatives be made to help parents develop a more internal locus of control with the goal of improving their ability to parent effectively.

ETHICAL APPROVAL

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

AUTHOR CONTRIBUTIONS

SN had the idea, JG planned and carried out the analyses with GE and SG; SN and JG wrote the first draft; all were involved in editing, checking and rewriting the paper.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2017.00546/full#supplementary-material

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Prenatal Internal Locus of Control Is Positively Associated with Offspring IQ, Mediated through Parenting Behavior, Prenatal Lifestyle and Social Circumstances

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Locus of control (LOC) is a measure that identifies the likelihood as to whether an individual considers what happens to him is largely a matter of luck or fate (known as externally oriented) or whether it is something that the individual can influence (internality). Here we have used data collected as part of the Avon Longitudinal Study of Parents and Children (ALSPAC) to determine the associations between the mothers' LOC orientation before the birth of the child and her child's cognition measured at age 8. Using results from 6801 children we show that maternal internal LOC is associated with increased ability in offspring IQ, as measured using the WISC, with children of internally oriented mothers having an advantage of approximately 7 IQ points at age 8. As a sensitivity analysis we used the IQ test results of a sample of 986 preschool children tested using the WPSSI at age 4. A similar advantage was found among the offspring of the internally oriented mothers. We investigated mechanistic explanations for these results firstly by determining the extent to which three separate sets of factors known to be influenced by the LOC orientation might explain these findings. We showed that (a) perinatal life-style exposures, (b) parenting attitudes and strategies and (c) socio-economic circumstances, largely explain the mechanism through which the internality of the mother influences the cognition of the child. Similar effects were found using the smaller sample tested at age 4. The results indicate that efforts made to foster internality in adolescents and young adults prior to parenthood may result in improvements in the cognitive development of the next generation. Intervention studies are urgently needed.

Keywords: ALSPAC, maternal locus of control, child cognition, child IQ, verbal IQ, performance IQ

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INTRODUCTION

The Importance of Locus of Control

The purpose of the present study was to examine the possibility that prenatal maternal locus of control (LOC) was associated with children's IQ outcomes and, if so, to identify possible mechanisms. The concept of LOC was introduced to psychology by Rotter (1966) who defined it as follows: "Internal vs. external control refers to the degree to which persons expect that a

reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics vs. the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues."

Since its introduction as a psychological construct, LOC has been the object of over 17,000 studies that have shown it to be related to a variety of personal and social outcomes (Nowicki and Duke, 1982, 2016; Nowicki, 2016). Its introduction into the psychological literature has most often been tied to cognitive and educational outcomes. In perhaps the largest and most influential study of its kind in the 1960s, Coleman et al. (1966) assessed nearly half a million students and found that LOC was the most significant predictor of educational outcomes in African American students and second most significant in European American students.

Reviews of LOC × academic achievement studies have shown internality to be associated with higher average grades and achievement test scores (Findley and Cooper, 1983; Kalechstein and Nowicki, 1997). In some instances, the LOC achievement association remained significant even when IQ scores were controlled for (Ollendick and Ollendick, 1976; Brown, 1980; Finch et al., 1988). Past research suggests that LOC orientation precedes academic achievement rather than vice versa (Stipek, 1980).

Surprisingly, research regarding the association between LOC and IQ is sparse. More often, studies have looked at the association between child IQ and child LOC with child and adult outcomes involving academic performance or educational attainment of some sort (Von Stumm et al., 2009). Aside from parent child rearing attitudes (Osborn and Milbank, 1987; Von Stumm et al., 2009; Wickline et al., 2011), rarely have parent personality factors like LOC, been examined for their possible association with children's IQ at different developmental times. One exception is Flouri (2006) who found that mothers' interest in their children's education and child internal LOC, predicted later higher educational attainment; mothers' LOC, however, was not assessed.

If a maternal personality factor like LOC was found to be significantly associated with child IQ outcomes, it offers the intriguing possibility that changing mother's LOC might be associated with a change in the expression of IQ in children across time. Of course, association is not causation, but it does suggest a place to look. Support for a possible parent LOC, child IQ outcome association comes from our previous research which showed that prenatal maternal internal LOC was associated with more positive personal and social outcomes in their children as early as age 4 weeks and as late as age 11 (Nowicki et al., 2017; Nowicki et al., submitted).

Of specific relevance to the present study, change in maternal LOC toward internality over the child's first 6 years was found to be associated with more positive teacher rated personality characteristics for children at age 8 and 11 years of age when compared to children of mothers who either remained or become externally controlled over the same time-period (Nowicki et al., in preparation). The authors argued that this was consistent with what can be expected theoretically and empirically. Thus compared to external mothers, internal mothers are likely to be more consistent and contingently responsive to their children's behavior, provide more stimulating family environments, emphasize earlier independence training, more often engage in granting autonomy, use less hostile and more educative disciplinary techniques and provide a warmer, emotionally secure learning environment (Carton and Nowicki, 1996; Schneewind, 1997; Wickline et al., 2011; Nowicki, 2016). These are all factors that would be likely to facilitate positively the expression of intellectual capabilities in their children.

The Present Study

The purpose of the present study was to examine the possibility that mothers' LOC measured during pregnancy would be associated with the IQ of their children at 8 years of age. It is hypothesized that, because theoretically, internality in mothers should be associated with the kinds of parenting behaviors that facilitate the expression of intelligence, it will be significantly related to higher IQ measured in children compared to children of prenatally external mothers. In addition, to assess whether the association is mediated by other factors that are linked to LOC orientation we considered parent attitudes, perinatal exposures to the fetus/infant including smoking and breast feeding, and social economic status. Supporting evidence will be sought using the IQ test results of a sub-group of the cohort at age 4.

MATERIALS AND METHODS

The Design of the ALSPAC Study

Avon Longitudinal Study of Parents and Children (ALSPAC) is a pre-birth cohort designed to determine the environmental and genetic factors that are associated with health and development of the study offspring (Golding and ALSPAC Study Team, 2004; Boyd et al., 2013). It recruited 14,541 pregnant women resident in Avon, United Kingdom with expected dates of delivery between April 1st, 1991 and December 31st, 1992 (an estimated 80% of the eligible population). Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, and linkage to other data sets. For full details of all the data collected see the study website: www.bristol.ac.uk/alspac/researchers/data-access/data-dictionary/.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees (LRECS). They agreed that consent was implied if questionnaires were returned. Informed written consent was obtained for all biological samples prior to analysis, and for certain invasive procedures during the optional hands-on assessments.

With advice from the ALSPAC Ethics and Law Advisory Committee it was decided not to enroll the study fathers directly, but rather to send to the mother a questionnaire for her partner and ask her if she would like her partner to be involved. If she wished she could give the questionnaire to him (or her) with a separate reply-paid envelope for return. As the study

deliberately chose not to record whether or not the mother had invited her partner to complete a questionnaire, it was unable to send reminders to the partners themselves. During pregnancy questionnaires were returned by 76% of partners of women who were taking part in the study.

As part of the study design, there was a concerted effort before the child's birth to obtain from the parents details of their personalities, moods and attitudes, including a measure of their LOC. The pregnant women were sent four questionnaires during the pregnancy, one of which contained the LOC scale; in parallel they were sent two questionnaires for their partners to complete.

The LOC Measure

The LOC measure used in the present study is a shortened version of the adult version of the Nowicki-Strickland Internal-External LOC scale (ANSIE). The ANSIE (Nowicki and Duke, 1974) comprises 40 items in a yes/no format, which assess perceived control. This measure 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, 2016). 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. The 12 questions loaded onto a single factor of general LOC. The 12 questions used are shown elsewhere (Golding et al., 2017). From the responses from 12,471 women a 'LOC score' was derived, the higher the score the more external the LOC. The scores ranged from 0 to 12. The frequency was normally distributed with a median of 4. For this study, external LOC was defined as having a score of >4. This cut-off identified 45.2% of the women as externally controlled (ELOC).

Measures of Cognition

IQ Testing at Age 8

The WISC-III ^{UK} (Wechsler et al., 1992) was used to assess cognitive function at age 8. At the time, it was the most up to date version of the Wechsler Intelligence Scale for Children, the most widely used individual ability test worldwide. A short form of the measure was employed where alternate items (always starting with item number 1 in the standard form) were used for all subtests, except for the coding subtest which was administered in its full form. Hence the length of the session was reduced and children were less likely to tire [such forms have been used successfully in several studies (Stricker et al., 1968; Finch and Childress, 1975)]. All tests were administered by members of the ALSPAC psychology team. The final WISC IQ scores (verbal, performance and total IQ) were calculated from the total scaled scores as described above using the look-up tables provided in the WISC manual.

IQ Testing at Age 4

Cognitive development at age 4 was assessed using the Wechsler Pre-school and Primary Scale of Intelligence or WPPSI (The Psychological Corporation, 1993) on a quasi-randomly selected 10% sample of the whole cohort. This assessment comprises 10 subtests, five verbal and five performance. The verbal subtest scores combine to make up the *verbal IQ* (VIQ), and the performance scores combine to make up the *performance IQ* (PIQ). The ten subtest scores together combine to produce a full-scale IQ score.

If a child completed fewer than four subtests on the performance scale then the performance IQ score could not be calculated (and therefore nor would the full-scale score). If, however, the child completed four out of the five, the mean of the four subtests was calculated and imputed for the subtest not completed, so that a performance score could be computed. This *prorating* is standard WPPSI practice. Identical rules apply for the verbal score.

Every effort was made to ensure inter-rater reliability. The testers were overseen by a tester with long experience of psychometric testing with ALSPAC. He observed each tester, advised them, met with the group regularly to discuss the precise administration of each test, and supervised and checked their scoring. Each tester scored four videos of tests and these were compared.

Variables Concerned with the Possible Mechanisms

Choice of variables considered as possible mediators concerned those variables which showed both an association with the mother's LOC and with the child's IQ as shown in **Table 1**. This demonstrates the associations between the 15 variables which we suspected might be on the causal pathway between the mother's externality and decreased offspring IQ. In general, the factors that are associated with the mother's LOC are also associated with the offspring IQ. Thus, the lifestyle, demographic and behavioral factors that are more prominent in the externally oriented mothers are reflected in an increased risk of an IQ < 100 in the offspring; this is particularly apparent for prenatal smoking, low maternal and paternal education level, maternal youth, residence in public housing, and a partner in a manual occupation. Conversely, factors that are less prominent in the externally oriented mothers are reflected in proportionately more children with an IQ ≥ 100 points (e.g., eating oily fish, breast feeding, parenting attitudes and behavior of the mother).

The Pre- and Perinatal Chemical Exposures

The following variables were included since there is considerable evidence to implicate these factors in neurocognitive development: (i) mother smoked cigarettes mid-pregnancy (yes/no); (ii) maternal alcohol consumption mid-pregnancy (yes/no); (iii) frequency of maternal consumption of oily fish in third trimester (none/infrequently/at least once a week); (iv) the baby was breast fed (none/any).

Parenting Attitudes and Strategies

The parenting attitudes and strategies were based on questions (mostly developed by the ALSPAC team) that the mothers answered in questionnaires completed at home and returned anonymously by post. The factors included were: (i) mothers' stated attitude during pregnancy to the need of a baby for stimulation (very positive/rest); (ii) the frequency that the mother

TABLE 1 | Possible mediators of offspring IQ at age 8: proportion of children with mothers in each category who are external or internal, and proportion of offspring with IQ < 100 or ≥100.

Potential mediator	Proportions of mothers		Offspring IQ	
	External	Internal	<100	≥100
Perinatal				
Mother smoked in pregnancy	27.3%	12.0%	18.4%	11.1%
Mother drank alcohol in pregnancy	47.1%	51.9%	48.4%	54.4%
Mother ate oily fish in pregnancy	49.7%	65.4%	54.7%	66.8%
Mother breast fed baby	68.5%	85.0%	73.5%	86.3%
Parenting				
Prenatal disagreement with need for stimulation	22.4%	10.6%	18.0%	10.7%
Mother reads to child 5+ times/week	70.0%	75.7%	72.8%	76.1%
High maternal parenting score	47.0%	53.1%	47.7%	54.9%
Child taken to library by mother	59.4%	72.0%	62.5%	74.7%
Mother sings to child 5+ times/week	70.0%	75.7%	72.8%	76.1%
Child has 10+ books	81.2%	91.2%	84.1%	93.9%
Demographic				
Maternal Education < 'O'level	44.4%	16.6%	34.0%	14.3%
Maternal age < 25	35.0%	19.5%	25.5%	15.2%
Resides in Council accommodation	20.7%	6.6%	13.6%	4.6%
Paternal manual social class	56.1%	34.0%	51.4%	30.5%
Paternal Education < 'O'level	44.9%	24.8%	42.6%	18.6%

read to the child at 18 months; (iii) a parenting score derived from the frequency with which the mother attempted to teach and interact with the child at 18 months, the higher the score the more positive the parenting (score ranged from 6 to 51); (iv) frequency with which mother took the child to a library at 42 months (5 point scale of decreasing frequency); (v) number of books child owned (<10/10+) and (vi) the frequency with which the mother sang to the child at 42 months (5-point scale of decreasing frequency).

Socio-Economic Circumstances

The variables used were all collected during pregnancy: (i) education level achieved by the mother (5-point scale from very low to University degree); (ii) education level of fathers (similar 5-point scale); (iii) maternal age at the birth of the child (<25; 25–34; 35+); (iv) social class based on the occupation of the father (non-manual/manual); (v) residence in council accommodation (public housing) (yes/no).

Statistical Approach

This study included all children who took the cognition tests at each age. At age 4, which was designed as a 10% sample of the whole cohort, 1027 children attended the clinic, and 1013, 1016, and 1013 (98.6%), respectively, completed the assessments for verbal, performance and full IQ. At age 8, all eligible children who were still resident in the area were invited. Of the 7488 who attended, 7385 (98.6%), 7377 (98.5%), and 7364 (98.3%) completed the tests to allow calculation of the verbal, performance and total IQ scores. Those children attending the test clinic had a mean age of 103.8 months (*SD* 3.9); 50.1% were boys and 3.9% were non-white; their mean birthweight was 3415 g (*SD* 554) and mean gestation 39.4 (*SD* 1.9) weeks. The mothers had a mean age of 29.1 years and the majority of women resided in owner occupied housing. A comparison of the non-attendees within this population indicated a bias in regard to socio-economic conditions (Supplementary Table 1). As the missing information was not missing at random, we have not used any form of imputation.

The analyses are designed to determine the relationship between the children's mean IQ scores and the mother's LOC orientation (comparing those who are external with those who are internal by subtracting the external from the internal). The basic data use an unadjusted multiple regression and note the regression coefficient (b), the measure of variance explained (R^2) and the statistical significance (P). The analysis was then repeated but taking account of the pre- and perinatal factors (Model A). A separate analysis allowed for the parenting variables (Model B), and a third analysis combined factors A and B. The fourth allowed for socio-demographic factors (Model C). The fifth analysis enabled all the factors in A, B, and C to be taken into account together. Comparison of the regression coefficients and the amount of variance explained for each model was used to deduce the contribution of the different factors in explaining the ways in which the maternal LOC may have impacted on the child's IQ level.

RESULTS

Relationship between Maternal LOC and IQ at 8

The unadjusted difference between the mean IQ of 8-year-old children whose mothers were external compared to those who

were internally oriented showed deficits of 7.33, 5.29, and 7.23 IQ points for the verbal, performance and full IQ scales, respectively (**Table 2**); each was highly significant ($P < 0.0001$). It is notable that the maternal LOC only explained 2.27% of R^2 for the performance IQ, whereas almost twice as much of the R^2 was explained for the verbal and full-scale IQ measurements.

To determine how much of the difference was explained by the different behaviors of external compared with internal mothers, we first tested how much the differences were mediated by pre- and perinatal features by comparing the regression coefficients of the unadjusted variable with that derived after allowing for Model A. This showed a drop in the difference for each of the three IQ measures of 1.84, 1.48, and 1.88 points (**Table 2**) or by 25, 28, and 26% of the original regression coefficient, respectively. Each of the four pre-/perinatal variables were independently associated in the model (data not shown).

Model B took the various parenting measures into account with very similar effects (**Table 2**): the reduction in IQ was by 25, 25, and 26%, respectively. All the parenting variables were independently associated with IQ except for the summary parenting score. A combination of Models A and B resulted in reductions of 41, 39, and 39% for the verbal, performance and full IQ measures; again, all the variables were significantly associated apart from the parenting score.

Model C involved the socio-demographic factors, and on its own accounted for reductions of 67–68% of each of the three IQ measurement differences between the children of externally oriented and internally oriented mothers. Each of the social factors had an independent effect.

Finally factors in each of Models A, B, and C were taken into account together. This resulted in a reduction in the regression coefficient from the baseline of 5.84, 4.32, and 5.75 IQ points or 80, 82, and 80%, respectively. The mediating variables that are significantly associated are shown in the final model (Supplementary Table 2).

Although the proportion of the effect size attributable to maternal externality has been similar in each of the verbal, performance and full IQ measures, both the effect size as measured by the regression coefficient and the actual variance of the IQ measures explained was much smaller for performance IQ compared to the verbal or full IQ measurements. This was true of the unadjusted measure as well as each of the final models (**Table 3**). Finally, we analyzed the data separately for boys and girls, but the results did not differ (data not shown).

TABLE 2 | The unadjusted and adjusted associations between the difference between the prenatal maternal internal and external locus of control (LOC) and mean IQ of the offspring at age 8.

Outcome and model	*b* [95% CI]	*n*	R^2 %	*P*
Verbal IQ				
Unadjusted	7.33 [6.53, 8.13]	6830	4.53	<0.0001
Model A	5.49 [4.63, 6.35]	6094	7.99	<0.0001
Model B	5.47 [4.59, 6.35]	5602	9.68	<0.0001
Model A + B	4.34 [3.43, 5.25]	5341	12.15	<0.0001
Model C	2.35 [1.50, 3.20]	5962	17.00	<0.0001
Model A + B + C	1.90 [0.96, 2.85]	4944	18.43	<0.0001
Performance IQ				
Unadjusted	5.29 [4.47, 6.11]	6822	2.27	<0.0001
Model A	3.81 [2.92, 4.70]	6083	4.22	<0.0001
Model B	3.98 [3.07, 4.90]	5591	5.12	<0.0001
Model A + B	3.25 [2.29, 4.21]	5331	6.32	<0.0001
Model C	1.71 [0.78, 2.63]	5955	8.36	0.0005
Model A + B + C	1.36 [0.34, 2.38]	4936	8.95	0.009
Full-scale IQ				
Unadjusted	7.23 [6.45, 8.02]	6801	4.56	<0.0001
Model A	5.35 [4.51, 6.19]	6066	8.10	<0.0001
Model B	5.46 [4.60, 6.32]	5575	9.96	<0.0001
Model A + B	4.39 [3.50, 5.28]	5315	12.23	<0.0001
Model C	2.35 [1.51, 3.19]	5938	17.15	<0.0001
Model A + B + C	1.93 [1.00, 2.86]	4922	18.79	<0.0001

Model A allows for pre- and perinatal exposures; Model B for parenting attitudes and activities; Model C for sociodemographic variables (see text for description of variables). b is the regression coefficient.

TABLE 3 | Summary of changes in regression coefficient and of the proportion of variance explained by the different models compared with the unadjusted model.

Model taken into account	Difference from unadjusted	Verbal IQ	Performance IQ	Full IQ
A	*b*	+1.84	+1.48	+1.88
	R^2 %	+3.46	+1.95	+3.54
B	*b*	+1.86	+1.31	+1.88
	R^2 %	+5.15	+2.85	+5.40
C	*b*	+4.98	+3.58	+4.88
	R^2 %	+12.47	+6.09	+12.59
A+B	*b*	+2.99	+2.04	+2.84
	R^2 %	+7.62	+4.05	+7.77
A+B+C	*b*	+5.43	+3.93	+5.30
	R^2 %	+13.90	+6.78	+14.23

Effects of Mediation

Thus the mediators we have chosen have demonstrated an explanation of about 80% of the LOC association that we have shown. It is highly likely that other behaviors of the mother (or her partner) may explain the remaining 20% of the association with LOC.

Sensitivity Analysis Using IQ at Age 4

The analysis of the IQ measure at age 4 used a much smaller sample of children, and consequently the confidence intervals are much larger than those found for the age 8 analyses. Nevertheless, there was clear evidence that maternal externality was associated with reduced full IQ even at this young age ($b = -7.82$ (95% CI -9.56, -6.09), $n = 986$, $P < 0.0001$). The final model allowing for A + B + C resulted in a reduction to $b = -1.24$ (95% CI -3.29, $+0.81$); $n = 742$; $P = 0.236$ (Supplementary Table 3). Although the lack of significance implies that there is no residual effect, the confidence limits of the effect size after adjustment includes the effect size shown after adjustment at age 8 (1.93).

DISCUSSION

The Importance of IQ Globally

A fundamental resource of individuals is their intelligence, yet there is no universal definition of this concept. Wechsler (1944) described it as 'the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment' but there is a myriad of other definitions (Legg and Hutter, 2007). Despite such confusion there are generally recognized measures of intelligence; the most widely recognized being the intelligence quotient (IQ) developed by Wechsler (1950).

There is evidence of high heritability (34–48%) but also evidence of *in utero* and other environmental effects (Devlin et al., 1997). Convincing evidence shows that the mean IQ of many developed populations, whether measured in infancy, childhood, or late adolescence, has increased over time (Dickens and Flynn, 2001; Lynn, 2009), thus suggesting the likely importance of environmental influences. Although there are arguments about definitions, heritability and measurement, it has become clear, irrespective of definition and test used, that data from brain-imaging and genetic studies are strongly correlated with results from intelligence tests, thus providing evidence for the validity of the IQ measurements (Deary et al., 2010).

As well as the obvious possible outcomes associated with intelligence such as academic achievement (Kalechstein and Nowicki, 1997), it is acknowledged that other broader outcomes may also be involved. For example, the financial success of nations may be tied to the abilities of their populations, which in turn are linked to their cognitive abilities. Thus, in Europe the gain of an IQ point was estimated to increase the GDP by 10,000 Euros per child in 2010 (Bierkens et al., 2012). Importantly also Veenhoven and Choi (2012) explored the relation between intelligence and happiness on two levels, at the micro-level of individuals and at the macro-level of nations. At the microlevel, they looked at the results of 23 studies and found no correlation between IQ and happiness. However, at the macro level, they assessed the correlation between average IQ and average happiness in 143 nations and found a strong positive relationship. They concluded that the findings suggest smartness of all pays more than being smarter than others.

The Environmental Influences on IQ

Although IQ is often assumed to be an innate characteristic of a child, the strong evidence of increasing IQ levels over time suggests that there is likely to be a major environmental component to its expression. Indeed there is excellent evidence that the IQ of the population can be increased using environmental exposures. This has been illustrated for breast feeding using a cluster randomized controlled trial in Belarus (Kramer et al., 2008) which resulted in 7.5, 2.9, and 5.9 verbal, performance and full IQ point increases among the groups encouraged to breast feed.

Here we have analyzed longitudinal data collected from pregnancy onward and shown that the mother's LOC is strongly associated with the child's IQ such that the mothers with an external orientation tend to have children with mean IQ about 7 points (almost half a standard deviation) lower than children of mothers with an internal orientation. This difference was observed at age 4 as well as at age 8 years. Further analysis of the 8-year-old data showed that this was largely mediated by perinatal and parenting features, and that socio-demographic factors also accounted for much of the difference.

Strengths and Weaknesses

Our data analyses may be criticized for analyzing LOC as a dichotomy rather than taking advantage of the continuous scale. We have done this because it is much easier to interpret than a small change on a continuous scale. Although we recognize that this may have masked variations that would have been informative, the fact that our results are similar when the analyses were repeated using a smaller sample, tested using a different scale on a different age group, adds validity to the findings. This subgroup of 4-year-olds showed a similar reduction in mean IQ among children of externally oriented mothers, and we were able to demonstrate that this was also largely mediated by attitudes, behaviors and achievements of external women.

However, there are a number of problems with our study: (i) we have not found a different longitudinal study that has data available to allow us to attempt to replicate these findings; (ii) the data used as mediators were all obtained from responses by the mother to questionnaires, rather than by direct observation; however, other studies have shown validation of maternal report using biomarkers in this cohort [e.g., maternal fish consumption with blood mercury and omega-3 fatty acid levels (Golding et al., 2013; Williams et al., 2001)]; (iii) we have shown that the children who had their IQ assessed were biased in terms of their social and environmental conditions. However, all of these factors were allowed for in the analyses, so bias in generalizing the longitudinal results may not be great.

One other possible disadvantage is that maternal IQ was not measured in this study. It is unclear as to what difference this may have made. Certainly there will be shared genes in common between mothers and their offspring, and it may be that certain genetic combinations will be more susceptible to environmental influences. Maternal education level could be considered a proxy for maternal IQ, but there is longitudinal evidence that a childhood external orientation often results in a failure of the individual to reach their full potential academically (Flouri, 2006).

In contrast there are a number of advantages to this study: (a) it is the largest study to date to determine the link between maternal LOC and IQ; (b) it is the only study that is prospective in nature with maternal LOC collected before the birth of the child, and consequently unaffected by the mother's perception of the child; (c) it is the only study to have collected and analyzed many of the factors that may explain the link between maternal externality and reduced child IQ;

(d) the IQ measures do not depend on report, but on direct assessment by trained psychologists unaware of the LOC of the mothers.

The Possible Mechanisms

We have suggested that if an external mother were to become more internal, her lifestyle in regard to her offspring would change to reflect the behavior we have found associated with internal mothers (**Table 1**), i.e., she would stop smoking (or never start), would eat a healthy diet and breast feed, her parenting behavior would improve, as would some of the demographics especially if she became more internal in early adolescence (e.g., she would have obtained higher educational qualifications, delay having children until her mid-twenties, would choose a partner who was more educated and who himself had an internal LOC). If we are correct in suggesting that these are on the mediating pathway, it is important to recognize that changing a mother's LOC to greater internality may result in consequent benefit to the child's cognitive ability. We suggest that this possibility be subjected to rigorous evaluation through controlled research studies changing LOC as summarized elsewhere (e.g., Nowicki, 2016).

CONCLUSION

We found that maternal external LOC in pregnancy is a strong indicator of lower IQ in her offspring, and that this is apparent by 4 years of age. This finding appears to be mostly associated with poor life choices made by the mother and consequent disadvantages to the child in infancy and early childhood. It would appear that efforts to increase the internality of the mother during her own childhood could generate the kinds of attitudes and behaviors that may result in an increase in the IQ of her offspring. An observational study such as this can point to such an effect, but conclusive support for these conclusions can only be obtained by a randomized controlled trial changing the LOC orientation of the female population before they become parents.

AUTHOR CONTRIBUTIONS

SN had the idea. JG planned the analyses. GE and SG undertook statistical analyses. SN and JG wrote the first draft. All authors contributed equally to writing later drafts, checking and editing.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2017.01429/full#supplementary-material

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Parental External Locus of Control in Pregnancy Is Associated with Subsequent Teacher Ratings of Negative Behavior in Primary School: Findings from a British Birth Cohort

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The purpose of the present study was to examine whether parents' locus of control (LOC) obtained before the birth of their child predicts the child's behavior at school in School Years 3 (ages 7–8) and 6 (ages 10–11). A modified version of the adult Nowicki–Strickland internal–external locus of control scale was completed by mothers and fathers in their own home during pregnancy. Externality was defined as a score greater than the median and internality as equal to, or less than, the median. Outcomes were the five individual subscales and the total difficulties of Goodman's strengths and difficulties' questionnaire completed by the children's class teachers at the end of School Years 3 and 6. As predicted, it was found that the greater the presence of externality in the parents, the greater the increased risk of the child's adverse behavior as rated by teachers. The risk was generally greatest if both parents were external and lowest if both were internal. There was a consistent relationship at both Year 3 and Year 6 between maternal externality in pregnancy and children's emotional difficulties. However, for other behaviors, the pattern of associations varied depending on whether the mother or father was external, the type of adverse behavior, and the School Year in which children were assessed. Prenatal parental externality appears to be significantly associated with a variety of children's negative behaviors. Of note was the finding that fathers' as well as mothers' LOC was important in determining children's outcomes. Implications of the complexity of the results for the role parents may play in children's personality and adjustment are discussed.

Keywords: ALSPAC, parental locus of control, child behavior, SDQ, teacher assessment

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INTRODUCTION

Most researchers believe that parents have a significant impact on their children's personality and behavior. Baumrind (1991) identified three parental styles, authoritative, authoritarian, and permissive and suggested that each was associated with different child outcomes. Generally, authoritative parenting is characterized by high warmth and responsiveness (e.g., Supple and Small, 2006). Authoritative parents establish clear rules for their

Abbreviations: ALSPAC, Avon longitudinal study of parents and children; ANSIE, adult Nowicki–Strickland internal–external locus of control scale; LOC, locus of control; SDQ, strengths and difficulties' questionnaire.

children and give reasons for their expectations (e.g., Carlo et al., 2007). In contrast, authoritarian parents exhibit high levels of controlling behavior and low levels of responsiveness (e.g., Luyckx et al., 2007) while permissive parents are high in responsiveness and low in demandingness. Research suggests that not only do negative parenting styles, such as excessive harshness or laxity, predict negative child outcomes, such as anxiety or externalizing behavior (e.g., Bayer et al., 2008), but positive parenting styles, marked by warmth and realistic boundaries, relate to positive child outcomes, such as empathy or prosocial behavior (e.g., Davidov and Grusec, 2006).

Although not studied as frequently as parental styles, parent personality may also be significantly associated with children's outcomes. By virtue of its association with behavioral outcomes, one possible parental variable is LOC. Rotter (1966) introduced the concept of LOC and defined it as a generalized problem solving expectancy as follows: "Internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues."

His article stimulated a remarkable amount of research involving the LOC construct for the next half century. Using a variety of LOC measures, investigators have published over 17,000 studies on this topic (Nowicki and Duke, 2016). Although many types of scales have been used to assess LOC, significant findings have been replicated across an impressive variety of psychological outcomes with internality such as improved academic achievement (e.g., Kalechstein and Nowicki, 1997; Flouri, 2006), sports performance (e.g., Arnaud and Palazzolo, 2012), and business success (e.g., Spector et al., 2002; Wu et al., 2015).

In one of the earliest reviews of the locus of control/personality/behavior relationships, Strickland (1978) concluded that externality, like parenting style, was "linked with pathological difficulties for both children and adults." Since that review, additional studies have provided results that support associations between external LOC and negative attitudes, personality characteristics, and behavior in both adults and children. For example, external LOC in *adults* has been associated with a variety of negative personality characteristics (e.g., Nowicki and Duke, 1974; Wheeler and White, 1991), depression (Benassi et al., 1988; Christensen et al., 1991; Bjørkløf et al., 2013), anxiety (Richert, 1981; Carden et al., 2004), and psychoses (Harrow et al., 2009; Weintraub et al., 2016).

Likewise, external LOC has been correlated with an impressive variety of negative personal and social outcomes in *children* (Nowicki and Duke, 1983; Nowicki, 2016, Manual for the Nowicki-Strickland internal external scales, Unpublished). Higher externality is related to increased chances of being: sexually abused (Beech and Ford, 2006), suicidal (Liu et al., 2005), depressed (Benassi et al., 1988; Luthar and Blatt, 1993), enuretic (Butler, 2001), learning disabled (Dudley-Marling et al., 1982), as well as having lower self-esteem (Wickline et al., 2011), attention deficit disorder (Ialongo et al., 1993), and more trouble persisting (McLeod, 1985). However, because most past studies are cross-sectional in design, cause and effect cannot be ascertained.

To further clarify the association between parental LOC and child outcome, one group of researchers has focused on the specific *parenting* LOC and not a global LOC in parents and its possible relationship with child behavior (Campis et al., 1986). Investigators have found that specific parenting externality in one or both parents was associated with negative outcomes in preschool (e.g., Estroff et al., 1994), preadolescent, and adolescent participants (e.g., Freed and Tompson, 2011), as well as a greater likelihood of receiving diagnoses of attention deficit/hyperactivity (Hoza et al., 2000) or anxiety (Becker et al., 2010). In addition, Moreland et al. (2016) found parenting externality to be associated with a greater likelihood of children being disruptive and less able to "cope," although when parenting LOC became more internal, their children's behavior also became less negative.

The possible connection between both global LOC and specific parenting LOC with children's outcomes is further supported by the results of other researchers. For example, Hagekull et al. (2001) found that greater parenting externality measured when children were 33 months and at 9 years of age was related to greater child difficulties both concurrently and prospectively. They concluded that the results pointed to "parents' perceived control as important for their children's development of externalizing and internalizing problems as well as for social and non-social competence development," and having an independent impact on development during the preschool years over and above infant temperament and acting out behavior.

While it is apparent that both generalized and specific parenting LOC are associated with a variety of child outcomes, fewer studies have examined how global *prenatal* parents' LOC is related to children's outcomes beginning soon after birth and through pre-adolescence. Because most past studies have gathered parent LOC and child behavior simultaneously, it makes the task of separating out who is affecting whom even more difficult. However, while not implying causation, having parent LOC obtained before it is affected by interactions with the child following birth can provide information about the parent LOC, child outcome association, not previously available. In an earlier set of analyses (Nowicki et al., 2017), we found that a generalized prenatal parent LOC predicted preschool children's personality and social behavior during the 5 years after their birth. We used data gleaned from ALSPAC, a cohort study which has been gathering data from parents and their children beginning during pregnancy in 1990–1992 (see section "Materials and Methods") to the present day. We found that prenatal parent LOC predicted child eating, sleeping, and anger management outcomes from birth to 5 years of life; the greater the presence of parent externality, the greater the likelihood of negative child outcomes as reported by the mother (Nowicki et al., 2017).

The purpose of this paper was to evaluate the association between prenatal parent LOC and school-age children's personal

and social behavior within the school environment. Teachers, unaware of the LOC of the parents, were asked to rate children's behavior based on what they observed in school. We aimed to ascertain whether prenatal parent externality continued to be associated with children's negative behavior in the school situation where they were not evaluated by family members, but by others (teachers) who observed them outside the home.

More specifically, the following predictions were made.

(1) Social learning theory (Rotter, 1954) and past empirical research (e.g., Lefcourt, 1982) suggest that the more external parents are the less likely they are to be organized, persistent, and responsible compared to their more internal peers. Because of these characteristics, external parents may be less able to solve child-raising problems with the result that their children will be more likely to have negative personality characteristics and behavioral difficulties. Therefore, it is predicted that the prenatal parent externality association with behavioral difficulties previously found in children up to age 5 will also be found at Year 3 (7–8 years of age) and Year 6 (10–11 years of age).

(2) Ollendick (1979) administered parents a generalized LOC scale, similar to the one used in the present study, to each parent. To analyze his findings, he created four combinations of parent LOC: both mother and father internal, father internal, mother external; mother internal, father external; both mother and father external. Ollendick predicted and found that the presence of externality in at least one parent, especially the mother, was associated with more negative child outcomes when compared with both parents being internal. We used a similar design and predict a similar result in the present study.

MATERIALS AND METHODS

Participants

The ALSPAC pre-birth cohort was designed to determine the environmental and genetic factors that are associated with health and development of the study offspring (Golding and ALSPAC Study Team, 2004; Boyd et al., 2013). As part of the study design, therefore, there was a concerted effort before the child's birth to obtain from the parents details of their own personalities, moods, and attitudes, including a measure of their LOC.

ALSPAC recruited 14,541 pregnant women who resided in Avon, United Kingdom, with expected dates of delivery between 1st April 1991 and 31st December 1992 (an estimated 80% of the eligible population). Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, and linkage to other data sets. With the advice of the ALSPAC Ethics and Law Advisory Committee, it was decided not to enroll the study fathers directly, but rather to send to the mother a questionnaire for her partner and ask her if she would like her partner to be involved, and if so whether she would be good enough to pass the questionnaire on with a separate reply-paid envelope for return. The study deliberately had no information on whether the mother had invited her partner to take part except when the completed questionnaire was returned. It should be noted that in consequence of this format, there was no way in which the study could send reminders to the partners themselves. In the event, at least one questionnaire was returned by 75% of the partners of women who were taking part in the study. The ALSPAC Ethics and Law Advisory Committee agreed that consent was implied if questionnaires were returned. Informed written consent was obtained for all biological samples prior to analysis and for certain invasive procedures during the hands-on assessments (which were optional to attend).

For this project, we have concentrated on the data collected from questionnaires completed by both the mother and her partner *before* the birth of the study child. The information on the child's behavior was obtained using a self-completion questionnaire completed by the child's teacher at the end of School Years 3 (ages 7–8) and 6 (ages 10–11). The study website contains details of all the data that are available through a fully searchable data dictionary: www.bristol.ac.uk/alspac/researchers/data-access/data-dictionary/.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

Exposure Measure: Locus of Control

The ANSIE (Nowicki and Duke, 1974) followed Rotter's definition in its construction. It has an easier reading level than the Rotter scale, and is significantly correlated with Rotter's test (Nowicki, 2016, Unpublished) making it appropriate for testing adults from the general population.

An anglicized and briefer form of the ANSIE was used in the present study. It contained the 12 items from the original 40 item scale which possessed the highest item-total correlations based on the responses of 135 mothers. The scales were completed by each parent at home in mid-pregnancy. Factor analysis of responses from 12,471 women confirmed the single factor structure of the scale. Coefficient alpha was 0.78 in this population. The scores ranged from 0 to 12 and were roughly normally distributed with medians of 4 and 3 for the mothers ($n = 12{,}471$) and their partners ($n = 8{,}645$) respectively. The higher the score, the more external the LOC. As in our previous publications, external LOC was defined as above the median while internal LOC was defined as scores equal to or lower than the median (Golding et al., 2017a,b,c; Nowicki et al., 2017). The median score for the mother was 4, and for the father, it was 3.

Child Outcomes: Strengths and Difficulties' Questionnaire

Class teachers completed the teacher version of the SDQ (Goodman, 1997), a widely used measure of child and adolescent mental health. This was administered toward the end of the school year (June–July) for study pupils in School Years 3 and 6 (when the children were aged approximately 7–8 and 10–11 years old, respectively). All primary schools in the study area were approached, and for the children who had moved out of the area, parents were sent the questionnaire to give to the teacher.

The questionnaire measures five mental health constructs under investigation in this study: attention difficulty/hyperactivity, conduct problems, emotional symptoms, peer difficulties, and prosocial behavior. Each construct is measured

with five items rated on a three-point Likert scale (0 – not true; 1 – somewhat true; or 2 – certainly true). Total scores for each construct range from 0 to 10, with higher scores indicating more severe problems, but greater (better) levels of prosocial behavior. A total difficulties score comprised the sum of the scores for each behavior except the prosocial score. When an item was not completed in a scale, it was prorated – i.e., replaced with the average for the other items in the scale for that child. Internal consistency across the different constructs of the SDQ and across different informants (self-report, teacher, and parent) has been found to be satisfactory (Cronbach's alpha mean of 0.73). Test–retest stability after 4–6 months has been reported to be 0.62 (Goodman, 2001).

Other Variables Considered

In order to assess the different confounders measured in pregnancy that could have influenced the results, we considered the following: maternal age (defined as her age at the last menstrual period prior to conception of the study child); parity (the number of previous pregnancies resulting in either a live or stillbirth); the housing situation [owner/occupied; council (public) housing; other rented]; crowding (ratio of the number of persons in the home divided by the number of rooms – excluding bathrooms and small kitchens); whether or not the woman was smoking in mid-pregnancy; whether she had had one or more days of binge drinking (4+ units of alcohol); maternal education (the highest educational achievements – 3 levels); whether she reported difficulty in affording to buy food; and whether she was depressed in mid-pregnancy (score of 12+ on the EPDS measure) (Cox et al., 1987).

Statistical Methodology

In this study, we explored the associations between the study child's behavior as reported by the teacher and the externality/internality of the parents. We compared the child's behavior outcomes using both the mean behavior scores (using multiple regression) and the risk of adverse behavior measured as the worst ∼10% of the score (using logistic regression). In order to distinguish between the risks of adverse behavior contributed by different numbers of external parents within the family, a derived variable concerning the number of such parents was used, and the results presented as odds' ratios with 95% confidence interval.

RESULTS

Bias in Response

The response rate of the primary school teachers of the study children had the advantage of not being biased by the social

TABLE 1 | Mean (SD) of child behaviors (unadjusted) as assessed by the child's teacher according to maternal and paternal LOC as measured in pregnancy. (The higher the prosocial score, the better the behavior, but for all other scales, the higher the score, the worse the behavior.)

SDQ	Mother external		Mother internal	Father external		Father internal
Year 3 (ages 7–8)	$N \sim 5656$			$N \sim 4002$		
Prosocial	7.57 (2.47)		7.86 (2.38)	7.76 (2.35)		7.86 (2.37)
		$P < 0.0001$			$P = 0.152$	
Hyperactivity	2.97 (2.78)		2.29 (2.51)	2.72 (2.71)		2.24 (2.50)
		$P < 0.0001$			$P < 0.0001$	
Emotional difficulties	1.53 (2.06)		1.25 (1.83)	1.43 (1.97)		1.27 (1.84)
		$P < 0.0001$			$P = 0.008$	
Conduct problems	0.89 (1.60)		0.59 (1.23)	0.75 (1.46)		0.59 (1.22)
		$P < 0.0001$			$P < 0.001$	
Peer difficulties	1.27 (1.82)		1.07 (1.70)	1.18 (1.78)		1.09 (1.72)
		$P < 0.0001$			$P = 0.138$	
Total behavioral difficulties	6.66 (5.99)		5.19 (5.20)	6.07 (5.71)		5.19 (5.24)
		$P < 0.0001$			$P < 0.0001$	
Year 6 (ages 10–11)	$N \sim 6500$			$N \sim 4527$		
Prosocial	7.82 (2.42)		7.97 (2.34)	7.85 (2.44)		8.13 (2.28)
		$P = 0.016$			$P < 0.0001$	
Hyperactivity	2.56 (2.73)		1.98 (2.49)	2.49 (2.74)		1.77 (2.33)
		$P < 0.0001$			$P < 0.0001$	
Emotional difficulties	1.38 (1.94)		1.19 (1.77)	1.37 (1.92)		1.18 (1.77)
		$P < 0.0001$			$P < 0.001$	
Conduct problems	0.96 (1.70)		0.68 (1.40)	0.92 (1.67)		0.58 (1.27)
		$P < 0.0001$			$P < 0.0001$	
Peer problems	1.25 (1.86)		1.17 (1.82)	1.27 (1.91)		1.10 (1.77)
		$P = 0.072$			$P = 0.002$	
Total behavioral difficulties	6.15 (5.94)		5.01 (5.50)	6.05 (6.10)		4.63 (5.16)
		$P < 0.0001$			$P < 0.0001$	

circumstances of the study families. Of the 12,471 children whose mothers had completed the LOC measure in pregnancy, there were 5660 (40%) and 6492 (52%) who had teacher reported SDQ scores in Years 3 and 6, respectively. Although no statistically significant differences were found between those circumstances of parents whose teachers responded compared with those who did not in regard of parity, difficulty affording food, binge drinking in pregnancy, maternal prenatal depression, or maternal LOC, there was a difference in the prevalence of young mothers and those living in rented housing (Supplementary Table 1). In addition, although attributes such as overcrowding, maternal smoking, and maternal education level differed for one of the two assessments, absolute differences were small.

The Child's Behavior and Each Parents' Individual LOC Orientations

The way in which the differing behavior scores and the parental LOC scores correlate is shown in Supplementary Table 2. The contemporaneous LOC comparisons were medium in size ($r = 0.32$), but the correlations between each LOC score and their children's behaviors were only small. However, such minimal results were detected only when the LOC scales were treated as continuous. When a dichotomy was used to distinguish externally oriented individuals from the rest of the population, a much clearer pattern was shown. Mothers who were external were more likely to have children judged negatively by the teachers on all scales of the SDQ at the end of Year 3, although prosocial behavior and peer problems scales had a much weaker association at the end of Year 6. In contrast, for the children of externally oriented fathers, relationships were minimal in Year 3 but were significant at 0.002 or lower in Year 6 (**Table 1**). In order to assess whether these differences were mirrored in lifestyle patterns, we charted the differences between the four groups (Supplementary Table 3). These conformed to the findings that external individuals were less likely to have obtained educational qualifications, but more likely to have babies earlier, smoke, binge drink, and be depressed in pregnancy.

The Child's Behavior and the Internality and/or Externality of the Pairs of Parents

In **Table 2**, the mean behavior scores of the children are shown for the four combinations of parents: both external; mother external, father internal; mother internal, father external; and both internal.

In every case in which both parents were external, their children had a greater number of teacher rated difficulties compared to children who had any other combination of parent LOC. The differences were significant in all cases in which children where both parents were external were compared to the children both of whose parents were internal. In general, the mean behavior difficulties scores where one parent was internally and one externally oriented were midway between the scores where both parents had an internal and both an external LOC. This was illustrated further by the relationship found between the risk of the child having a behavior difficulty score in the worst 10–15% of scores and the number of parents who had an external LOC (**Table 3**). Unadjusted data show the risk of adverse behavior for each extra external parent. In general, except for prosocial behavior in School Year 3 and peer problems at both time points, there were significant increases in risk for

TABLE 2 | Mean (SD) of teacher ratings of child behavior using SDQ according to the LOC orientation of the child's parents as measured in pregnancy.

Child behavior	M.Ex. F.Ex	M.Ex. F.In	M.In. F.Ex	M.In. F.In
Hyperactivity				
Year 3	2.99 [2.79]	2.57 [2.66]**	2.40 [2.58]	2.07 [2.40]**
Year 6	2.74 [2.84]	2.00 [2.39]***	2.16 [2.56][a]	1.66 [2.28]***
Emotional problems				
Year 3	1.53 [2.05]	1.43 [2.01]	1.30 [1.85]	1.19 [1.74]
Year 6	1.44 [1.97]	1.28 [1.92]	1.28 [1.84]	1.13 [1.70]*
Conduct problems				
Year 3	0.87 [1.61]	0.72 [1.38]*	0.59 [1.26]	0.53 [1.13]
Year 6	1.02 [1.74]	0.61 [1.26]***	0.77 [1.55][a]	0.56 [1.27]***
Peer problems				
Year 3	1.26 [1.81]	1.19 [1.81]	1.06 [1.72]	1.04 [1.67]
Year 6	1.28 [1.90]	1.07 [1.71]*	1.25 [1.93]	1.11 [1.80]
Total difficulties				
Year 3	6.66 [5.97]	5.91 [5.59]**	5.34 [5.26]	4.83 [5.01]*
Year 6	6.47 [6.23]	4.96 [5.01]***	5.46 [5.85][a]	4.46 [5.18]***

*[a]Difference between M.Ex.F.In and M.In.F.Ex: P < 0.05. (The higher the score, the worse the behavior.) [Asterisks indicate differences between the pairs of father orientation as *P < 0.05; **P < 0.01; ***P < 0.001.]*

TABLE 3 | The change in the odds of the child's adverse behavior according to the numbers of parents who have an external orientation during pregnancy [odds are per increase in one external parent].

Child behavior	Unadjusted		Adjusted[a]	
	OR [95% CI]	*P*	OR [95% CI]	*P*
Prosocial				
Year 3	1.04 [0.91,1.19]	0.559	1.00 [0.86,1.16]	0.962
Year 6	**1.24 [1.09,1.40]**	**0.001**	**1.23 [1.08,1.41]**	**0.003**
Hyperactivity				
Year 3	**1.40 [1.25,1.57]**	**<0.001**	**1.32 [1.16,1.50]**	**<0.001**
Year 6	**1.61 [1.43,1.81]**	**<0.001**	**1.49 [1.30,1.70]**	**<0.001**
Emotional symptoms				
Year 3	**1.26 [1.12,1.41]**	**<0.001**	**1.18 [1.04,1.34]**	**0.011**
Year 6	**1.20 [1.08,1.35]**	**0.001**	1.12 [0.99,1.26]	0.079
Conduct problems				
Year 3	**1.50 [1.30,1.73]**	**<0.001**	**1.32 [1.12,1.54]**	**0.001**
Year 6	**1.52 [1.34,1.72]**	**<0.001**	**1.37 [1.19,1.57]**	**<0.001**
Peer problems				
Year 3	1.09 [0.96,1.24]	0.185	1.09 [0.95,1.14]	0.615
Year 6	1.07 [0.95,1.21]	0.234	1.05 [0.92,1.19]	0.449
Total difficulties				
Year 3	**1.45 [1.28,1.64]**	**<0.001**	**1.34 [1.17,1.54]**	**<0.001**
Year 6	**1.39 [1.24,1.56]**	**<0.001**	**1.25 [1.10,1.43]**	**0.001**

Bold values are statistically significant at P < 0.05. [a]Adjusted for maternal age, residence in public rented housing, and child's sex.

each extra external parent. The greatest change in risk was found for hyperactivity in Year 6 (with an increased risk of 61% per increase in one external parent), and conduct problems at both time points (increase of approximately 50%). Adjustment reduced the odds' ratios to a certain extent, but only for emotional symptoms were the significances of the relationships considerably reduced.

In order to examine whether Ollendick's (1979) prediction that mothers' as opposed to fathers' internality would have a more positive impact on child outcomes, we selected parent combinations in which either the mother or the father was external, while their corresponding parent was internal. As shown in **Table 4**, this prediction was supported by findings at Year 3, where children were similar in age to Ollendick's; internal mothers paired with external fathers had children whose teachers rated them more favorably on all the specific SDQ behaviors as well as on the total difficulties scale compared to external mothers and internal fathers, although none of the differences were statistically significant. However, somewhat surprisingly, this relationship was reversed when examining Year 6 children who were considerably older than those used by Ollendick. Here, except for emotional problems, external fathers paired with internal mothers were more likely to have children with more difficulties compared to external mothers with internal fathers. Examination of the proportions of children with the worst behavior scores revealed a similar pattern (Supplementary Table 4).

When individual SDQ scales are examined, all mean differences are in the direction of showing that the more parents that were external, the larger the increase in child's behavior difficulties. After adjustment, the effect sizes reduced slightly but almost all were statistically significant with the exception of prosocial behavior in Year 3 and peer problems in Year 6 (Supplementary Table 5). The findings suggest that prenatal parent externality is associated with a greater number of negative children's outcomes, depending on the developmental stage of the children.

These findings suggest the intriguing possibility that mothers' internality may be more important when children are younger than older and that fathers' LOC may be more likely than mothers' to be associated with children's behavior when they approach adolescence.

TABLE 4 | Comparison between the odds of the child's adverse behavior when just one parent is externally oriented during pregnancy [odds are for difference if it is the mother who is external].

Child behavior	Unadjusted		Adjusted[a]	
	OR [95% CI]	*P*	OR [95% CI]	*P*
Prosocial				
Year 3	1.22 [0.87,1.71]	0.254	1.20 [0.85,1.71]	0.299
Year 6	0.82 [0.59,1.13]	0.215	0.82 [0.58,1.14]	0.240
Hyperactivity				
Year 3	1.12 [0.83,1.51]	0.452	1.12 [0.83,1.54]	0.446
Year 6	0.84 [0.61,1.14]	0.257	0.89 [0.64,1.24]	0.497
Emotional symptoms				
Year 3	1.20 [0.90,1.61]	0.222	1.23 [0.91,1.65]	0.174
Year 6	1.04 [0.78,1.39]	0.797	1.03 [0.76,1.38]	0.868
Conduct problems				
Year 3	1.15 [0.80,1.66]	0.453	1.11 [0.76,1.63]	0.588
Year 6	**0.68 [0.49,0.95]**	**0.026**	0.75 [0.53,1.06]	0.103
Peer problems				
Year 3	1.20 [0.87,1.66]	0.263	1.21 [0.87,1.68]	0.255
Year 6	**0.67 [0.49,0.92]**	**0.012**	**0.67 [0.49,0.93]**	**0.015**
Total difficulties				
Year 3	1.32 [0.96,1.81]	0.084	1.31 [0.95,1.81]	0.105
Year 6	0.81 [0.59,1.11]	0.194	0.86 [0.62,1.19]	0.369

Bold values are statistically significant at P < 0.05. [a]*Adjusted for maternal age, residence in public rented housing, and child's sex.*

DISCUSSION

The greater the presence of externality in parents prenatally, the greater the number of teacher rated difficulties in their children approximately 8 and 11 years later. Children's behavioral outcomes were not assessed by their parents, but by independent observers (their teachers) with no knowledge of parents' prenatal LOC orientation. Putting the present study's findings together with those of an earlier one (Nowicki et al., 2017) suggests that the association between prenatal parental externality and negative children's behavior is present soon after birth in the childhood home and continues to be present when children attend full time school, at least up to preadolescence.

The present study examined the association not only between completely internal or external parent combinations and child outcomes but also between parent dyads in which one parent was internal and the other external and child outcomes. Using the four combinations of prenatal parent LOC allowed for the evaluation of the contribution of each parent's LOC orientation to the association with children's outcomes. In most cases, it did not appear to matter whether the mother or the father was the source of parent externality, the result was the same; externality was associated with negative child outcomes. Although girls had fewer absolute numbers of teacher rated difficulties than boys, they showed a similar pattern of prenatal parent externality associated with negative outcomes.

The results are comparable to those obtained during the first 5 years of life (Nowicki et al., 2017). Children of parents who were both prenatally externally controlled experienced more difficulties in sleeping, eating, and dealing with anger than their peers who had parents who were both prenatally internally controlled. However, unlike in the present study, the child outcomes and interactions took place within the home and parents were responsible for reporting on their child's outcomes.

What is it about parental externality that may translate into how they interact with their children? Campis et al. (1986) suggest that parents "with external parental LOC orientations possess several negative concomitant attitudes about their parental roles such as low self-efficacy and a sense of being dominated by their child's demands." Lefcourt (1982) agrees.

Using the assumptions of Rotter's (1954, 1966) social learning theory, Lefcourt reasoned not only that externally controlled parents would tend to see their children's behavior as being outside their own efforts, but because they saw themselves as relatively powerless they would be inconsistent in setting limits for their children's activities. This lack of structure, consistency, and limits could create problems for children attempting to learn, through feedback, how to behave appropriately.

One possible way of affecting the parent externality/child negative behavior association would be to provide ways for parents to learn to be more internal. Support for this possibility comes from Hagekull et al. (2001) who found that changes toward parenting internality was also associated with fewer indications of behavioral problems in their children. It remains to be seen if changes in a more generalized LOC would have a corresponding effect on children's rated difficulties.

Perhaps what schools could do to help children coming from families with prenatally external parents is to provide children with the kinds of learning experiences and structures to help them become aware of, and to learn from, the connections that exist between how they behave and what happens to them. Such experiences may help children develop appropriate levels of internal control; such changes may function to neutralize the possible negative impact of parental externality. If, on the other hand, that kind of intervention is beyond the resources of the schools, teachers could modify their teaching methods to provide more structure for children coming from the unstructured environments provided by externally controlled parents. Such interventions have proved to be successful with externally controlled children who have been found to respond more effectively to structure and primary reinforcement than their internal peers (Nowicki, 2016).

Limitations

Although previous researchers have found authoritative parental style related to children's internality and authoritarian parental style to children's externality (e.g., Wickline et al., 2011), they have failed to identify parental practices that may connect parental style and LOC with children's outcomes. Darling and Steinberg (1993) were among the first to suggest that it is parental practices and not parenting styles that have a more direct impact on children's outcomes. While past studies have had some success identifying parent behaviors associated with children's LOC orientations (Carton and Nowicki, 1994; Carton et al., 1996), there is a lack of information about actual parental practices and behaviors shown by different parenting styles in relation to their LOC orientations.

Because cause and effect could not be established in the present study, it is not only possible, but probable that parent and child temperament, cognitive ability, and the like would affect the parent LOC/child outcome association. Future researchers should investigate the role of these and other personality and cognitive factors, as well as seeking to identify parent and child behaviors that characterized parent dyads differing in externality especially when parents and children are interacting with one another.

It must also be acknowledged that the present study did not include an analysis of the possible impact of ecological factors like family, neighborhood, or community on the parent prenatal LOC/child outcomes. Bronfenbrenner (2015) has pointed out the limiting and facilitating effect ecological factors can have on parent, child interaction.

CONCLUSION

In the present study, children's outcome data were gathered from independent raters from outside the home. The children were in school and rated by teachers, not family members, thereby eliminating the potential for parent bias to affect the results. Teachers' judgments of children's outcomes were consistent with those gathered from parents' ratings obtained earlier in life; greater presence of prenatal externality was associated with negative child outcomes in children 8 and 11 years later.

AUTHOR CONTRIBUTIONS

SN had the idea; JG planned the analyses; GE and SG undertook the statistical analyses; JG and SN wrote the first draft. All authors contributed equally to writing later drafts, checking, and editing.

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SUPPLEMENTARY MATERIAL

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The Pattern of Stability and Change in Parental Locus of Control Over 6 Years and Teacher Ratings of Child Behavior

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A previous study from our group showed that parents' locus of control (LOC) obtained before the birth of their child was associated with the child's behavior at school in School Years 3 (ages 7–8) and 6 (ages 10–11). Here we examine whether a change in parental LOC over the first 6 years of the child's life was associated with differences in his or her behavior as rated by their teachers. As before, we use data from the Avon Longitudinal Study of Parents and Children (ALSPAC). A modified version of the adult Nowicki–Strickland internal–external LOC scale was completed by mothers and fathers in their own home during pregnancy and 6 years later. Externality was defined as a score greater than the median and internality as equal to, or less than, the median. Outcomes were the five individual subscales and the total difficulties of Goodman's Strengths and Difficulties Questionnaire (SDQ) completed by the children's class teachers at the end of School Years 3 and 6. As predicted, we found that parents who remained externally oriented, or became external, had children with more behavioral difficulties in primary school compared with parents who remained or became internal. Type of behavior difficulties varied somewhat with whether mothers or fathers remained or changed toward externality. These results support the possibility that changes in parental LOC are associated with children's personal and social adjustment. Consequently, programs to change parental LOC may be worth evaluating.

Keywords: ALSPAC, parental locus of control, child behavior, teacher SDQ, change over time, mother, father, longitudinal cohort study

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INTRODUCTION

Locus of control (LOC) is a personality construct related to a variety of outcomes. Rotter (1966) introduced that construct and defined it as follows: "Internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues."

Investigators have published thousands of LOC studies using adults (Nowicki and Duke, 2016) and found internality (having an internal LOC) related to *higher academic achievement*

(e.g., Kalechstein and Nowicki, 1997; Flouri, 2006), *better sports performance* (e.g., Arnaud and Palazzolo, 2012), and *business success* (e.g., Spector et al., 2002; Wu et al., 2015); and externality (having an external LOC) to a variety of *negative personality characteristics* (e.g., Duke and Nowicki, 1973; Wheeler and White, 1991), *depression* (e.g., Bjørkløf et al., 2013), *anxiety* (Carden et al., 2004), and *psychoses* (Harrow et al., 2009; Weintraub et al., 2016).

External LOC is also associated with negative personal and social outcomes in children (Nowicki and Duke, 1983; Nowicki, 2016, unpublished), *suicidal* (Liu et al., 2005), *depressed* (Benassi et al., 1988; Luthar and Blatt, 1993), *enuretic* (Butler, 2001), *learning disabled* (Dudley-Marling et al., 1982), having *lower self-esteem* (Wickline et al., 2011), *attention deficit disorder* (Ialongo et al., 1993), and *less ability to persist* (McLeod, 1985).

While external orientation has been related to negative outcomes in both adults and children, few researchers have examined the possible associative role parent externality might play in their children's lives. There are both theoretical and empirical reasons for assuming parent LOC might be associated with child outcomes. Descriptively, internality is characterized by factors that should make for better parenting, e.g., being more thoughtful, less impulsive, more responsible, persistent and able to delay gratification, as well as tendencies to gather more information from environments (Rotter, 1966, 1975, 1990; Lefcourt, 1976, 1981, 1982, 1983). Campis et al. (1986) suggest that parents "with external parental LOC orientations possess several negative concomitant attitudes about their parental roles such as low self-efficacy and a sense of being dominated by their child's demands." (p. 265). Lefcourt (1982) agrees and reasoned not only that externally controlled parents would tend to see their children's behavior as being outside of their efforts, but they also would be inconsistent in setting limits for their children's activities. Lack of structure, consistency, and limits would create problems for children attempting to learn, through feedback, how to behave appropriately. Empirically, parental internality has been associated with positive, and externality with negative child outcomes (Nowicki, 2016). Using a specific parenting LOC scale (Campis et al., 1986), researchers found that parenting externality in one or both parents was associated with negative outcomes in *preschool* (e.g., Estroff et al., 1994), *preadolescent, and adolescent participants* (e.g., Freed and Tompson, 2011) as well as a greater likelihood of receiving diagnoses of *Attention Deficit/Hyperactivity* (Hoza et al., 2000) or *anxiety* (Becker et al., 2010).

The possible connection between the parenting LOC and children's outcomes is supported by others. For example, Hagekull et al. (2001) found that greater parenting externality, measured when children were aged 33 months and 9 years, was related to greater child difficulties both concurrently and prospectively. They concluded that parents' perceived control is important for their children's development of externalizing and internalizing problems as well as for social and non-social competence development, and of having an independent impact on development during the preschool years over and above infant temperament and acting out behavior.

Using a generalized LOC scale consistent with Rotter's definition (i.e., one that is not focused on particular features such as a medical condition or parenting strategies), Nowicki et al. (2017) found an association between prenatal parent LOC and children's personality and social behavior. They used data from the Avon Longitudinal Study of Parents and Children (ALSPAC) (Golding and ALSPAC Study Team, 2004; Boyd et al., 2013; Fraser et al., 2013), reporting that prenatal parent externality was associated with greater numbers of child eating, sleeping, and anger management problems during the first 5 years.

To evaluate whether the association of prenatal parent externality with negative children's outcomes extended into later childhood, Nowicki et al. (2018b) compared teacher ratings of students' emotion and behavior difficulties using the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997, 2001) in School Years 3 and 6. Generally, prenatal parent externality was positively associated with a greater number of difficulties. Father externality was associated strongly with conduct difficulties for boys and mother externality with emotion problems for girls, but total number of teacher rated difficulties was related to the presence of externality in both parents. These findings were consistent with those of Hagekull et al. (2001) who found that mothers' externality was more strongly associated with children's internalizing difficulties in contrast to fathers' externality which was related to externalizing problems.

For the present study, we sought to examine how stability and change in parent LOC over the first 6 years of children's lives were associated with their emotional and behavioral difficulties at the end of School Years 3 and 6. Previously, Nowicki et al. (2018a) found a correlation of 0.55–0.56 between each parent's LOC before the birth of their child and 6 years later. These moderate correlations suggest that many parents changed their LOC orientation over the 6 years. Our aim was to evaluate whether the degree and type of parent change in LOC over time was differentially associated with children's emotional and behavior difficulties.

Previous results showed parental externality as measured by specific parenting LOC (e.g., Campis et al., 1986) or generalized LOC (Golding et al., 2017; Nowicki et al., 2018b), was related to negative child outcomes. Based on past empirical results, we predicted that children of parents who remained external or changed from internal to external would have a greater number of behavior difficulties when compared to parents who remained, or became, internal during that time.

MATERIALS AND METHODS

The Population Studied

This research takes advantage of data collected by ALSPAC. Initiated in 1990, it recruited 14,541 pregnant women who were resident in an area of south-west England, and due to deliver between 1st April 1991 and 31st December 1992. The initial number of pregnancies enrolled is 14,541 (for these at least one questionnaire has been returned or a "Children

in Focus" clinic had been attended by 19/07/99). Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14,062 live births and 13,988 children who were alive at 1 year of age. The aim was to study ways in which the environment (including psychological, social as well as chemical impacts) together with the genetic characteristics, influenced the health, development and well-being of the offspring. Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the local research ethics committees (Birmingham, 2018). The ALSPAC Ethics and Law Advisory Committee agreed that consent was implied if questionnaires were returned. Informed written consent was obtained for all biological samples prior to analysis, and for certain invasive procedures during the hands-on assessments (which were optional to attend).

Data were collected using a variety of resources including self-completion questionnaires (completed by parents, children, and teachers), assays of biological samples, linkage to other data sets, and hands-on examinations. For this study, we use data from parents in pregnancy and 6 years later, linked to data from primary school teachers of their offspring at two time points [School Years 3 and 6 (aged 7–8 and 10–11), respectively]. Please note that the study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool: http://www.bristol.ac.uk/alspac/researchers/our-data/

The Exposures: Parental LOC

ALSPAC used the Adult Nowicki Strickland Internal External control scale (ANSIE) (Nowicki and Duke, 1974, 1983; Nowicki, 2016, unpublished) that followed Rotter's definition in its construction. It has an easier reading level than the Rotter scale and is significantly correlated with Rotter's test (Nowicki and Duke, 1983) making it appropriate for testing adults from the general population. The scale has been used in over 2,000 studies (Nowicki, 2016, unpublished).

More specifically, Nowicki (2016) reports split-half reliabilities in the 0.60 s for college ($\underline{n}$ = 156) and community samples ($\underline{n}$ = 33). These split-half reliabilities seem to be satisfactory in light of the fact that these personality items are not arranged according to difficulty. This makes the split-half reliabilities an underestimate of the true internal consistency reliability. Further report of internal consistency estimates of KR20s of 0.69 for a male sample ($\underline{n}$ = 40) and 0.39 for female sample ($\underline{n}$ = 40) were found. Nowicki and Duke (1983) reported test–retest reliability for college subjects over a 6-week period were 0.83 ($\underline{n}$ = 48), which was comparable to what Chandler (1976) found over a 7-week period ($\underline{r}$ = 0.65, $\underline{n}$ = 70) and Roueche and Mink (1976) found over a year ($\underline{r}$ = 0.56, $\underline{n}$ = 854) for community college students.

An anglicized and briefer form of the ANSIE was administered to each of the parents in pregnancy and 6 years later. It contained 12 items from the original 40-item scale which possessed the highest item-total correlations based on the responses of a pilot sample of 135 mothers. Each item had a simple binary answer, with the consequence that the score ranged from 0 to 12. The scales were completed by each parent at home. The higher the score the more external the LOC. As in our previous analyses, external LOC was defined as above the median while internal LOC was defined as scores equal to, or lower than, the median. The median score for the mother at the two-time points was 4 and 3, and for the father it was 3 at both.

The Outcome Measure: Child's Behavior

The behavior of the study child was recorded on paper questionnaires, one for each child in the class, by the child's class teachers toward the end of School Years 3 and 6. All primary schools in the study area were approached, and for the children who had moved out of the area, parents were sent the questionnaire with a reply paid envelope to give to the teacher.

The child's behavior was rated using the 25-item SDQ (Goodman, 1997), a well-validated method that measures five attributes: prosocial behavior, hyperactivity, conduct problems, emotional difficulties, and peer problems. Each attribute comprises the answers to five questions rated on a three-point Likert scale (0 – not true; 1 – somewhat true; or 2 – certainly true). From these questions scores were calculated, the higher the score the more problematic the behavior, except for the prosocial score where the reverse was true. If the answer to an item was missing, the score was prorated taking account of the other answers in that subscale. A 'total difficulties score' is the sum of the behaviors (excluding the prosocial behavior) (Goodman, 1997). Internal consistency across the different constructs of the SDQ and across different informants (self-report, teacher, and parent) has been found to be satisfactory (Cronbach's Alpha mean of 0.73). Test–retest stability after 4–6 months has been reported to be 0.62 (Goodman, 2001).

Data Analysis

We documented ways in which changes in LOC of each parent were associated with the child's behavior as reported by the teacher. This analysis assesses whether mothers' and fathers' changes in LOC orientations have similar or different associations and stratifies by sex of the child to determine whether there are different associations. Numbers in each of the strata are found in the last rows of the tables.

For measuring change over time, we considered four strata for each parent: those that stayed external at each time point (Ext.Ext); those who started external but became internal (Ext.Int); those who were internal at both time points (Int.Int), and those who started internal, but were external 6 years later (Int.Ext). Results are given as the mean behavior score with its standard deviation (SD). As in a previous paper (Nowicki et al., 2017), we compare statistically the outcomes between (Ext.Ext) and (Ext.Int), as well as between (Int.Ext) and (Int.Int), using a two-tailed 2-sample *t*-test.

As a supplementary exercise (**Supplementary Tables 5, 6**), we present the effect sizes of differences in behavior scores using Cohen's *d* (Valentine and Cooper, 2003), and employing the standard deviation of the reference group (i.e., those who remained internal).

RESULTS

Comparison of the Behaviors Over Time

Comparison of the behavior scores in years 3 and 6 indicates that, in general, the children became more prosocial, less hyperactive and had fewer total difficulties within each of the maternal change groups, whereas the other types of behavior were not consistent in this respect (**Table 1**).

Associations of Child Behaviors Among Women Who Had an External LOC in Pregnancy

Altogether there were 1,612 women who were externally oriented during pregnancy and for whose offspring the teachers' behavior rating was available at year 3 (1,856 at year 6). As can be seen from **Table 1**, scores for hyperactivity, conduct problems, and total difficulties were significantly better for children of mothers who became internal, but only for year 6; prosocial behavior was unaffected by the change in the mothers' LOC, but emotional and peer difficulties showed no significant differences.

Comparison of the relationships between the two sexes separately (**Supplementary Tables 1, 2**) shows that, as the external mothers' orientation changed from external to internal, the behavior of the boys was significantly less hyperactive and they had fewer conduct problems in year 6. No such findings were found in year 3, or for other behaviors in year 6. For girls whose mothers had become internal, all behaviors were better and the differences in prosocial, hyperactive and emotional behaviors as well as total difficulties were statistically better in year 6.

Associations of Child Behaviors Among Women Who Had an Internal LOC in Pregnancy

The numbers of women who were internally oriented in pregnancy, and whose offspring had been given an SDQ score by their teachers were 2245 and 2751 for years 3 and 6. A comparison of the children whose mothers became external compared with those whose mothers remained internal (**Table 1**) shows that in year 3 those children with mothers remaining internal were significantly more prosocial, less hyperactive, had fewer conduct problems, peer difficulties and total difficulties. In year 6, the children whose mother had become external were significantly more hyperactive, and had increased levels of emotional problems, conduct problems and total behavioral difficulties.

Examination of the sexes separately (**Supplementary Tables 1, 2**) shows boys had significant increases at both time points in the hyperactive and total difficulties scores if their mothers had changed from internal to external. Conduct problems only significantly increased for boys in year 6. Girls only showed associations in year 3 with hyperactivity, conduct problems and total difficulties – each problem

TABLE 1 | Relationship between the mean [*SD*] scores of child's behavior using the Strengths and Difficulties Questionnaire (SDQ) and the **changes in maternal LOC** between pregnancy and 6 years later.

Outcome and school year	Stayed external	Changed external to internal	Changed internal to external	Stayed internal
Prosocial				
Year 3	7.68 [2.43]	7.68 [2.43]	7.79 [2.40]	8.02 [2.30][d]
Year 6	7.95 [2.39]	7.95 [2.39]	7.94 [2.38]	8.09 [2.26]
Hyperactivity				
Year 3	2.75 [2.68]	2.65 [2.72]	2.49 [2.66]	2.04 [2.34][c]
Year 6	2.39 [2.67]	1.92 [2.44][a]	2.06 [2.50]	1.75 [2.33][c]
Emotional				
Year 3	1.43 [1.97]	1.38 [2.02]	1.26 [1.83]	1.18 [1.76]
Year 6	1.30 [1.88]	1.16 [1.82]	1.25 [1.84]	1.12 [1.67][d]
Conduct Problems				
Year 3	0.77 [1.47]	0.74 [1.45]	0.63 [1.27]	0.48 [1.06][d]
Year 6	0.86 [1.57]	0.61 [1.20][b]	0.68 [1.37]	0.55 [1.19][d]
Peer Difficulties				
Year 3	1.23 [1.82]	1.13 [1.68]	1.13 [1.77]	0.98 [1.59][d]
Year 6	1.16 [1.77]	1.13 [1.85]	1.14 [1.84]	1.10 [1.71]
Total Difficulties				
Year 3	6.20 [5.62]	5.89 [5.76]	5.51 [5.41]	4.67 [4.79][c]
Year 6	5.71 [5.63]	4.82 [5.43][a]	5.13 [5.53]	4.51 [4.98][d]
Numbers rated				
Year 3	1261	351	652	1593
Year 6	1432	424	1033	1718

The higher the prosocial score the better the behavior, but for all other scales the higher the score the worse the behavior. Comparison of columns 1 and 2: [a]$P \leq 0.01$; [b]$P < 0.05$. Comparison of columns 3 and 4: [c]$P \leq 0.01$; [d]$P < 0.05$.

behavior was significantly increased if the mother had become external.

Comparisons Across all Four Groups

In **Table 1**, a comparison of the pattern of results for children whose mothers remained external with those whose mothers remained internal shows poorer offspring behavior if the mother remained external. Comparison of those who became internal (Ext.Int) with those who became external (Int.Ext), however, reveals some slight differences between the two: the Ext.Int group had children with slightly worse behavior in year 3, but slightly better behavior in year 6 than those whose mothers became external. For boys, these differences are most marked for hyperactivity, conduct problems, and total difficulties. For girls they are also marked for emotional difficulties.

Changes in Paternal LOC Orientation

It should be noted that the numbers of fathers available for analysis were smaller than the number of mothers, and consequently there was less statistical power. Nevertheless, there were significant associations, some similar and some different to those found for the mothers. Among children whose fathers changed from external to internal (**Table 2**) there were significantly better hyperactive and conduct behaviors at both years 3 and 6; the total difficulties score was also better in year 3. For the children whose fathers changed from internal to external, only one behavior showed a significant difference – those in year 3 were less hyperactive. Subdivision by the child's sex again showed differences in hyperactivity and conduct problems in boys, but not significantly so in girls (excepting those in year 3 whose fathers changed from external to internal) (**Supplementary Tables 3, 4**).

DISCUSSION

In this paper, we have shown that higher numbers of children's difficulties were associated with higher parent externality, whether externality was unchanged over 6 years or the result of a change toward externality during that time. This was consistent with our past results, showing that children of external parents had more problem behaviors beginning at a very young age (Nowicki et al., 2017, 2018b). We also showed that in no instance did children of parents who remained external or became external over the 6 years have fewer difficulties than children of parents who stayed internal or became internal.

Parent externality has been associated with an assortment of children's difficulties over the first 11 years of life (Nowicki et al., 2017, 2018b). A core finding from past studies was that the greater the presence of maternal and paternal prenatal externality the greater the problems children experienced. When parental prenatal LOC was mixed, children had fewer problems than when both parents were external, but more difficulties than when both parents were internal. In addition, the parent LOC/child difficulties relation was, at times, differentially affected by each parent's LOC and whether the child was male or female. In

TABLE 2 | Relationship between the mean [*SD*] scores of child's behavior using the Strengths and Difficulties Questionnaire (SDQ) and the **changes in paternal LOC** between pregnancy and 6 years later.

Outcome and school year	Stayed external	Changed external to internal	Changed internal to external	Stayed internal
Prosocial				
Year 3	7.90 [2.27]	8.11 [2.21]	7.84 [2.42]	7.91 [2.35]
Year 6	8.03 [2.37]	8.32 [2.21]	8.21 [2.39]	8.23 [2.15]
Hyperactivity				
Year 3	2.59 [2.66]	2.12 [2.40][a]	2.29 [2.56]	1.96 [2.28][b]
Year 6	2.23 [2.61]	1.72 [2.41][a]	1.72 [2.43]	1.56 [2.15]
Emotional				
Year 3	1.41 [1.91]	1.40 [1.90]	1.24 [1.94]	1.19 [1.74]
Year 6	1.28 [1.85]	1.23 [1.93]	1.16 [1.79]	1.12 [1.67]
Conduct Problems				
Year 3	0.75 [1.56]	0.42 [0.91][a]	0.59 [1.17]	0.51 [1.13]
Year 6	0.79 [1.52]	0.52 [1.16][a]	0.58 [1.31]	0.45 [1.06]
Peer Difficulties				
Year 3	1.13 [1.67]	1.04 [1.64]	0.98 [1.60]	1.07 [1.70]
Year 6	1.08 [1.73]	1.27 [2.02]	1.06 [1.69]	1.04 [1.63]
Total Difficulties				
Year 3	5.89 [5.62]	4.98 [4.88][a]	5.11 [5.23]	4.73 [4.81]
Year 6	5.39 [5.55]	4.73 [5.65]	4.51 [5.40]	4.17 [4.54]
Numbers rated				
Year 3	499	252	288	953
Year 6	593	263	319	1036

The higher the prosocial score the better the behavior, but for all other scales the higher the score the worse the behavior. Comparison of columns 1 and 2: [a]$P < 0.05$. Comparison of columns 3 and 4: [b]$P < 0.05$.

this study, specific associations differed depending on (1) the direction of parental LOC change, (2) which parent changed and in which LOC direction, (3) the sex of the child, and (4) the type of child behavior difficulty shown.

For example, compared to mothers who remained external, mothers' changing from external to internal had daughters with fewer *total*, *emotional*, and *hyperactivity* difficulties and more *positive prosocial* ratings. Fathers' externality did not play as important a role in associations with their daughters as did mothers; compared to fathers who remained external, those who became internal had daughters with fewer difficulties only in *hyperactivity*.

Changes in mothers' LOC toward internality were more often associated with positive aspects of their daughters' behavior than fathers' changes. It may be that mothers' internality provide a protective buffer for their daughters as they deal with the social demands of preadolescence. Preadolescence is an important developmental period, one in which girls begin to develop more depressive symptomatology than boys (Nolen-Hoeksema, 2002). While there is conjecture as to why preadolescent and adolescent girls develop depression, an association between mothers' externality and the number of emotion problems involving depression and anxiety may deserve consideration for possibly clarifying the process of why some girls develop depression and others do not. We do know that adolescents' own internality can act as a buffer against depression in high-risk adolescents (Culpin et al., 2015) and it could be that mothers' internality functions in the same way for their daughters.

With the exception of *hyperactivity* in year 3, fathers' change in LOC appears to have little or no relation to their daughters' difficulties, but that is not the case with their sons. Fathers who became internal as opposed to those who remained external, had sons with fewer difficulties in *conduct* and *hyperactivity* at both School Years 3 and 6. Mothers who became internal had a similar relation to their sons' outcomes, but only at School Year 6.

The parent internality/fewer conduct difficulties association may help clarify the mechanisms underlying the increase in "acting out" behavior that takes place in preadolescent and early adolescent boys (e.g., Farrington, 2009). Boys who act out are more likely to have parents who show ". . .inconsistent discipline and low monitoring" (Berg, 2012, p. 634). Mothers and fathers who are internal are more likely to parent with more consistency and control and provide protection against developing behavior difficulties (Campis et al., 1986). This possibility awaits research verification.

The internal to external findings are the mirror opposite to those from external to internal transformations. Parents who became external tended to have children with more difficulties than those who remained internal; parents who became internal tended to have children with fewer difficulties than those who remained external. The presence of externality is associated with more difficulties while the presence of internality reflected fewer problems. The interplay of types of LOC and child difficulties is consistent.

In this paper, we have documented the patterns of change in LOC and child behavior that occur over time in this unique dataset. We have not undertaken analyses to determine the possible mediating factors that may have been a consequence of these changes in LOC, at this stage, but we do intend to do so in the future. For example, we have previously shown that factors such as maternal diet and smoking in pregnancy, whether she breast fed her offspring, read stories or fed the toddler with "junk" food, partly mediated the association between parental externality and the relatively low IQ of the offspring (Golding et al., 2017).

A substantial number of parents changed their LOC orientation over the first 6 years of their children's life and these changes were differentially associated with children's difficulties. While we do not yet completely know which life events correspond to parent LOC changes, one study found greater stress involving relationships, finances, and health and illness to be associated with changes toward externality or maintaining externality (Nowicki et al., 2018a). In contrast, less stress and progress toward financial, relational, and healthful stability were associated with remaining internal or becoming internal. Programs to change the identified risk factors associated with externality could be implemented to examine whether the change plays a significant role in changing parent LOC toward internality, and in turn whether changes toward parental internality are associated with positive changes in children's behavior. In one of the few studies to provide information in this regard, Moreland et al. (2016) examined outcomes in preschool children as a function of parenting LOC (as measured by the specific parental control subscale of the Parental LOC scale) in both mothers and fathers. The authors were interested in determining if a parenting intervention would have a beneficial impact on both the stress level and LOC of parents along with concomitant positive change in their children's behavior. Before the intervention, externality in mothers and fathers was related to greater disruptive behavior and lower cognitive coping in children. However, the successful intervention not only lowered parental stress and made them more internal, but children's disruptive behavior decreased, and their coping skills increased suggesting interventions to make parents more internal may also increase the likelihood that children's behavior also will improve.

If programs are not available to change parent LOC, Nowicki et al. (2018a) suggested that school personnel could provide structured experiences to facilitate children learning to become appropriately internal. With appropriate levels of internality, children may be more able to buffer themselves against the possible negative consequences of parental externality. Hopefully future research will provide evidence to evaluate this possibility.

Strengths and Difficulties of the Project

A major strength is that the children were observed in school for many months by their class teachers, not family members, eliminating the potential for parental bias. Compared to parents, teachers have more opportunity to observe children's social and behavioral successes and failures as they interact with a variety of peers and adults across academic and social situations at differing times. They also have the advantage of being able to compare the child's behaviors with those of his/her peers. A second strength is the longitudinal nature of the study, with LOC measures being obtained before the child is born (thus minimizing bias that may be associated with characteristics of the newborn child). Thirdly,

the relationship between the change in the LOC of the study fathers compared with the child's behavior is unique. Fourth, the numbers involved in the study are substantially greater than any similar study.

Our strategy of categorizing parental LOC in relation to the median has the disadvantage that a small change in some score can significantly change an individual from internal to external, and vice versa. However, this is likely to have minimized, rather than exaggerated any differences. The fact that we have not analyzed the data using multivariable techniques may be seen as a fault. This was, however, a deliberate decision. The factors that are normally taken into account (e.g., maternal teenage pregnancy; smoking and alcohol consumption; employment status; and parental education level) are often, in themselves, the consequence of having an external LOC. Therefore, allowing for such factors would have been an over-control. Consequently we have treated this study as a search for pattern. Elsewhere we assess other consequences of parental LOC orientation to the individual child (e.g., Golding et al., 2017).

CONCLUSION

Changes in parental LOC are associated with child outcomes over the first 6 years of the child's life. If parents' LOC remains internal or changes toward internality over time, then children's outcomes are more positive than if they remain external or become external. Although parents remaining internal was always found to be associated with more positive outcomes than when both parents remained external, positive child outcomes were sometimes dependent on whether the child was male or female and which parent was internal or external. Additional research is needed to ascertain whether there is a cause and effect relationship between changes in parental LOC and children's outcomes.

AUTHOR CONTRIBUTIONS

JG and SN: conceptualization, funding acquisition, and writing – original draft preparation. YI-C: writing – review and editing, and project management. SG and GE: data curation, formal analysis, and investigation.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01427/full#supplementary-material

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Stability of, and Associations Between, Parent and Child Locus of Control Expectancies

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The purpose of the present study was to assess the stability of locus of control (LOC) scores over time using data gathered from tests constructed to be consistent with Rotter's definition of LOC. We compared LOC scores of parents (measured prior to the birth of the index child and at 6 and 18 years later) and their offspring (at ages 8 and 16) to explore how stable adult and child LOC was over time and to see how parental LOC was associated with the LOC of the child aged 8 and again at 16. Locus of control was measured using modified versions of adult (ANSIE, Nowicki and Duke, 1974) and child (CNSIE, Nowicki and Strickland, 1973) LOC scales, administered to participants in the Avon Longitudinal Study of Parents and Children in the United Kingdom. We predicted that: (1) adult scores would be more stable than children's and (2) parents' and children's LOC scores would be related to one another. Analyses of the data found that individual's LOC scores were significantly associated over time, with adult scores ($r \sim 0.50$) more highly correlated than children's ($r \sim 0.20$). Correlations suggest more stability for adults than children, but also indicate the occurrence of substantial change across time. Although statistically significant, correlations between family members were small at both childhood and adolescent time points. Additional analyses suggested that mother and father LOC scores were more highly correlated with opposite rather than with same sex children, but again though significant the coefficients were small. We also analyzed the binary outcomes of externality to assess parental contributions to externality in the 8 and 16-year-old children and found correlations were significant, but small. Possible explanations are offered for why the associations between parent and child LOC were not higher. We concluded that researchers need to focus more on clarifying how children's LOC is acquired.

Keywords: ALSPAC, longitudinal cohort, parental locus of control, child locus of control, adolescent locus of control, stability over time, Rotter's concept of locus of control

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INTRODUCTION

Over a half century ago, Rotter (1966) introduced the concept of locus of control of reinforcement (LOC) to the psychological literature defining it as a generalized problem-solving expectancy functioning within his social learning theory. Within that now classic article, Rotter also presented a test to measure the degree to which reinforcement outcomes were perceived to be related to behavior. He defined LOC as follows: "Internal versus external control refers to

the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues" (p. 1).

By Rotter's definition, LOC is a *generalized expectancy* which means that it varies in its impact as a function of an individual's greater or lesser experience across and within situations. As a generalized expectancy, LOC is assumed to have its maximum impact on behavior when individuals have little or no experience in the situation or when the situation is ambiguous, amorphous, or fluid. As experience is gained from being in a specific situation, the ability of a generalized expectancy, such as LOC, to affect behavior diminishes and specific expectancies learned from being in the situation become more important. However, should a situation change and therefore become "new" again (as for example when a company is going through a management transition or when a child faces a change in teachers in school) then generalized expectancies may once again become an important predictor of behavior.

We emphasize Rotter's unique definition of LOC because, since he introduced it, researchers have employed various terms interchangeably with Rotter's, or used "locus of control" to refer to constructs other than the one offered by Rotter. In fact, 30 years after Rotter's article, not only did Skinner (1996) find that Rotter's LOC of reinforcement term had been shortened to simply "control," but that over a 100 different terms had been used to describe it such as: " . . .personal control, sense of control, LOC, cognitive control, agenda control, outcome control, primary control, secondary control, action control, decisional control, predictive control, informational control and proxy control. . .." Moreover within the total set of terms, some appear to be different labels for the same construct. For example, Bandura (1977) referred to "a personal estimate that a given behavior will lead to a certain outcome" (p. 193) as "response-outcome expectancies," whereas Heckhausen (1977) labeled the subjective probably that one's actions will modify a situation "action-outcome expectancy," and Seligman (1975) described the degree of the relationship between responses and outcomes in terms of "contingencies."

Although two decades have passed since Skinner's comprehensive review, Nowicki and Duke (2016) noted there was still confusion about what is and what is not LOC. They suggested some of the confusion may be the result of what Kelley (1927) called "jingle" and "jangle" fallacies in the presentation of concepts. In the "jingle fallacy" a single term is used to describe different things. For example, researchers use "locus of control" but define it differently than Rotter's description of a generalized expectancy (Lachman and Weaver, 1998; Cobb-Clark and Schurer, 2013). In contrast the "jangle fallacy" occurs when a different term such as "sense" of control is used synonymously with LOC (e.g., Ahlin and Lobo Antunes, 2015).

To the two conceptual fallacies offered by Kelly, we add a third, "the jumble fallacy" in which researchers use constructs like self-efficacy (Bandura, 1977) and attribution (Seligman, 1975), interchangeably with Rotter's LOC construct. Although Peterson and Stunkard (1992) have clearly pointed out the conceptual differences among the three constructs, many researchers still switch efficacy, attribution, and LOC with one another as though they are referring to the same construct which they are not.

Problems in the Measurement of Locus of Control

Compounding the confusion created by the existence of so many LOC terms are the difficulties originating in the 100s of different tests used to measure them. Unfortunately, there is not a review of LOC tests comparable to the one Skinner completed for "terms." Part of the measurement problem is that researchers often do not present construct validity evidence for their LOC test as Rotter did with his (see Cronbach and Meehl, 1955). Rotter (1966) used data from many studies to establish "preliminary" construct validity for his definition of LOC. As suggested by Cronbach and Meehl, Rotter built his test by sampling items from the universe of items consistent with his definition of the construct and then provided evidence to accept or reject associations predicted by it.

Unfortunately, other LOC researchers have not always been as thorough in presenting evidence of their tests' construct validity. In one case, a single test item was used (Conell-Price and Jamison (2015). In other instances, items used to measure LOC were taken from tests constructed to measure other constructs such as "coping" (e.g., Cobb-Clark and Schurer, 2013) and were not accompanied by any other construct validity support aside from internal consistency estimates. Rarely do researchers present test data revealing the relationship with Rotter's LOC test or any other test of "locus of control."

In summary, past researchers have not always made it clear how their control conceptualizations and the tests used to assess them relate to Rotter's initial construct or with one another. This makes it difficult to assess how results using one test generalize to those found with others.

Pertinent to this point, Twenge et al. (2004) collected Rotter's test results for adults and Nowicki and Strickland findings for children over a 30-year period and reported that scores became more external over time. Some years later, Trzesniewski and Donnellan (2010) using data from another 30-year study of high school seniors concluded that there were no changes toward externality over time. However, the authors used a seven-item scale with unknown construct validity to reach their conclusion in contrast to Twenge, Zhang, and Im who used scales with known construct validity. The lack of convergent and discriminative evidence of the validity of tests makes it difficult to know how findings of different studies relate to one another.

Because of the confusion caused by different conceptualizations of LOC and the paucity of construct validity data of tests employed to assess them, in the present study we return to Rotter's original definition of LOC and use data collected from tests developed consistent with his definition. Much previous research gathered about the stability of individuals' LOC over time was gathered from cross-sectional studies using small numbers of non-representative participants.

There are exceptions. The British Child Health and Education Study (CHES) was a large cohort study that included participants from the United Kingdom born during a 1 week (Elliott and Shepherd, 2006). An Anglicized form of the Nowicki and Strickland test was administered to children aged 10. Scores predicted adult outcomes regarding obesity, blood pressure, and educational attainment (Flouri, 2006; Gale et al., 2008). The test was re-administered when children were 16, and Furnham and Chen (2016) found that childhood intelligence, self-esteem, neuroticism, and earlier child adjustment were antecedents associated with LOC at this age. However, no attempt was made to assess LOC stability between ages 10 and 16.

As mentioned above, Twenge et al. (2004) found that both adults and children became more externally controlled over time. However, the data were cross-sectional and did not follow individuals over time. We could find only two studies that met the criteria of being longitudinal and used tests consistent with Rotter's definition: Schneewind (1997) and Lekfuangfu et al. (2017).

Schneewind had parents and children take LOC tests as part of a longitudinal study of family relationships. The initial test took place when children were age 10 and parents' mean age was 36. Sixteen years later Schneewind was able to retest 100 parents and their children. He found that over the 16 years, parent LOC correlated in the 0.50s while children's scores were in the 0.20s. In addition, parent/child LOC associations, though significant, were small.

Lekfuangfu et al. (2017) used a larger cohort than Schneewind, but also used Anglicized versions of the Nowicki and Strickland LOC tests. They focused on mother's prenatal LOC and subsequent parenting and child outcomes. Using an economic perspective in which subjective belief in control (LOC) was conceptualized to reflect the degree of investment in child outcomes, they found that prenatal maternal internality was associated with more effective parent attitudes that in turn were related to more time and attention to children and better achievement outcomes. The researchers did not include fathers or other time periods.

The Present Study

In the present study we use tests constructed to be consistent with Rotter's concept to examine the stability of adult LOC measured before the child was born (mean maternal age 26; paternal age 29) and measured again when the child was age 6 (adult mean parental ages 32 and 35) and 18–20 (parental mean ages 44 and 49). In addition, we assess the stability of children's locus of score between the ages of 8 and 18.

No previous study has included both mothers' and fathers' LOC obtained prenatally and 6 and 18–20 years later as well as measures of their children's LOC during childhood and adolescence. This structure not only allows us to examine the stability across time of different age groups, but also to assess the associations between children and their parents during childhood and adolescence. Previous information regarding the stability or change of LOC as measured by Rotter defined LOC tests during a life time has primarily come from cross-sectional studies.

Stability of Locus of Control: Children

We are tracking the generalized LOC of reinforcement across significant developmental periods for children and adults. When developing the children's Nowicki and Strickland LOC scale the authors stated outcomes needed for the scale to obtain preliminary construct validity: (1) scores will become more internal with increasing age, (2) scores will be related to achievement with internals achieving more than externals, (3) scores will not be related to measures of social desirability, (4) scores will be related to scores from other tests of LOC. Support was found for the predicted outcomes (see section "Materials and Methods" for more specific construct validity information).

There are significant psychological and physiological changes that take place between age 8 and age 16 that may, in turn, produce changes in LOC. In reality, because of their increasing physical, cognitive and psychological maturation, children gain more control over outcomes with time. Cross-sectional data suggest children become more internal with age, but do not tell us if that is what takes place within individuals as they move from childhood into adolescence. Schneewind (1997) found correlations in the 0.20s between children's LOC scores at age 10 and their scores at age 26.

Stability of Locus of Control: Adults

The Adult Nowicki and Strickland Internal-External control scale (ANSIE, Nowicki and Duke, 1974) was constructed by modification of the children's scale by changing the word "children" to "people" (n = 6) and the present tense to the past tense (n = 5). This was done to provide a LOC scale for non-college as well as college adults that was consistent with Rotter's definition, but with an easier reading level. More detail about the ANSIE is presented in the measures section.

Typical adults continue to change toward internality until they reach older age (Nowicki, 2018a, unpublished[1]) and some theorists (e.g., Lachman, 2015) have described adults as going through developmental life changes as do children. However, typical changes in adults wouldn't be as large as they would be with children and should result in more stable LOC expectancies. Schneewind found correlations in the 0.50s between LOC of adults when their children were age 10 and when their children were age 26. However, he did not test adults before children were born and therefore could not assess the impact the birth of a child could have on their LOC.

Locus of Control Associations Among Mother, Father, Son, and Daughter

There is surprising little research upon which to base predictions for the LOC associations within a family (see Ollendick, 1979). Only one previous study (Schneewind, 1997) included assessment of fathers as well as mothers and he found correlations between mothers' and fathers' LOC were higher than they were between either of them and their child. Because of a lack of past empirical research, no predictions were made for within family associations.

[1]Nowicki, S. (2018a). *A Manual for the Adult Nowicki Strickland Internal External Scale (ANSIE)*. Georgia: Emory University.

MATERIALS AND METHODS

Participants

The Avon Longitudinal Study of Parents and Children (ALSPAC) was designed to determine the environmental and genetic factors that are associated with the health and development of the study offspring (Golding and The ALSPAC Study Team, 2004; Boyd et al., 2013; Fraser et al., 2013). As part of the study design there was a concerted effort to obtain baseline details on parents' personalities, moods and attitudes, including a measure of their LOC, prior to the baby's birth. ALSPAC recruited 14,541 pregnant women residing in Avon, an area of south-west England, with expected dates of delivery between 1st April 1991 and 31st December 1992. Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14,062 live births, 13,988 of whom were alive at 1 year of age. Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, teacher reports and linkage to other data sets. Please note that the study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool: http://www.bristol.ac.uk/alspac/researchers/our-data/.

The mothers and offspring have been followed throughout, but partners were only included initially with the permission of the mothers. Mothers were given a questionnaire which they could pass to their partner if they wished him to participate; partners were given their own reply-paid envelope in which to return their completed questionnaires to avoid potential bias and protect confidentiality.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee [ALEC; IRB00003312] (registered on the Office of Human Research Protections database as U Bristol IRB #1), and the Local Research Ethics Committees. The Committees agreed that consent was implied if questionnaires were returned, and informed written consent was obtained from all participants who underwent certain invasive procedures undertaken during the hands-on assessments (which were optional to attend), and for all biological samples prior to analysis (see Birmingham, 2018).

Measures

Adult Nowicki and Strickland Internal External Control (ANSIE Nowicki and Duke, 1974)

Parents completed an abbreviated version of the ANSIE (Nowicki and Duke, 1974). The ANSIE was an upward extension of the Children's Nowicki and Strickland Internal-External scale (CNSIE, Nowicki and Strickland, 1973) that was constructed to meet the need for an easier to read version of Rotter's LOC scale that could be given to community samples. In the initial stages of construct validation both the Rotter and ANSIE scales were given to samples of adults and found to be significantly correlated with one another ($r = 0.42$). Nowicki and Duke (1974) report split-half reliabilities in the 0.60s for college ($n = 156$) and community samples ($n = 33$). These split-half reliabilities seem to be satisfactory in light of the fact that these personality items are not arranged according to difficulty. This makes the split-half reliabilities an underestimate of the true internal consistency reliability (others have reported KR-20s in the 0.60s; Nowicki, 2018a, unpublished[1]). Factor analyses suggest a single factor, "helplessness" accounted for 29% of the variance (see Nowicki, 2018b, unpublished[2]). Nowicki (2018b, unpublished[2]) reports test–retest reliabilities ranging from 0.83 for 6 weeks to 0.56 for a year.

Discriminative validity

Duke and Nowicki (1974) investigated the relationship of ANSIE scores to social desirability. This was important because Rotter's scale had been found to be significantly related to social desirability. Two samples of college students ($n = 48$, $n = 68$) were asked to complete the Marlowe–Crowne Social Desirability scale. Consistent with the requirements of discriminative validity, ANSIE scores were not related to scores from the social desirability measure [$r(47) = 0.10$; $r(67) = 0.06$]. Other studies reported in Nowicki (2018a, unpublished[1]) also have found ANSIE scores to be unrelated to social desirability scores.

Construct validity

Basically, the philosophy of construct validation implies that a new measure of a construct should show a significant relationship with well-established measures of that construct. An example of such a procedure is the correlating of a new measure of intelligence with the Stanford–Binet or with the Wechsler scales. If, however, the authors of a new measure assume the new measure adds something unique or measures the construct more accurately than the established measure, then the resulting relationship with the established measure should be somewhat less than identity. This is important to our present purpose. Since Rotter and others who have used his scale have amassed a large amount of data consistent with theoretical predictions from social learning theory, favorable comparison with this scale is indicated. It is predicted, therefore, that if the ANSIE scale is measuring the same construct as the Rotter scale the two should be significantly related. However, if the ANSIE is accounting for a unique portion of variance, then correlations between the measures should be positive, but should fall in the moderate range.

To assess the association between the ANSIE and the Rotter scales, Nowicki and Duke (1974) administered both scales to two college and community adult samples. In all three samples, the correlations between the two measures were significant and consistent with requirements [$r(47) = 0.68$, $p < 0.01$; $r(37) = 0.48$, $p < 0.01$]. These results are consistent with the contention that these two measures are assessing the same construct, but not in an identical manner. Nowicki, (2018b, unpublished[2]) reports that results of three other studies found ANSIE and Rotter scores correlated in the 0.50s.

Nowicki (2018b, unpublished[2]) reports studies whose results show ANSIE scores being related to participants' race and socio-economic level in similar ways as Rotter's scores with externality higher in non-white populations and lower socio-economic levels. The same pattern is true regarding evidence

[2]Nowicki, S. (2018b). *A Manual for the Children's Nowicki Strickland Internal External scale (CNSIE)*. Georgia: Emory University.

of psychological difficulties; externality is higher in those with psychiatric diagnoses, anxiety, and depression. Finally, similar to Rotter's results, in a number of studies ANSIE test scores have been related to achievement as measured by standardized test scores and grade point average.

The ANSIE appears to meet the minimal requirements necessary for its use as an appropriate measure of LOC in adults. Further work is reported in Nowicki and Duke (1983), Nowicki (2016) and Nowicki (2018a, unpublished[1]).

The ANSIE scale used in the present study was developed specifically for ALSPAC; it comprised 12 questions taken from the original 40 question scale. The ANSIE was chosen over health-related scales because it was a generalized scale consistent with Rotter's definition and has the potential to relate to a wider range of outcomes. This shortened ANSIE was validated on a sample of 135 pregnant women prior to use in ALSPAC. It was administered within self-completion questionnaires posted to the mothers during pregnancy, and subsequently 6 and 18 years later. In parallel, during pregnancy and 6 years post-delivery, the mothers were sent questionnaires for their partners to complete with identical LOC questions. When the study offspring were 20 years old, fathers were invited to a clinic, where they responded to a computerized questionnaire which included the identical set of LOC questions. Scores were computed by adding the number of external type answers; they ranged from 0 to 12 with higher scores indicating greater externality.

Children's Locus of Control: Children's Nowicki and Strickland Internal, External Scale (CNSIE, Nowicki and Strickland, 1973)

The children's LOC measure used in the present study was an adaptation of the CNSIE (Nowicki and Strickland, 1973). The CNSIE has been used in over a 1000 studies that have provided data supportive of its construct validity (Nowicki 2018b, unpublished[2]). The Nowicki and Strickland Internal–External control scale is a paper and pencil measure of the LOC measure consisting of 40 questions answered by marking either the yes or no place next to the question. The final form of the scale derived from work which began with the construction of items (n = 102) based on Rotter's definition of the internal–external control of reinforcement dimension. The items described reinforcement situations across areas such as affiliation, achievement, and dependency. School teachers helped in the construction of the items. The goal of such item construction was to make the items readable at the third-grade level yet appropriate for older students. To accomplish such a goal, the 102 items along with Rotter's definition of the LOC dimension were given to a group of clinical psychology staff members (n = 9) who were asked to answer the items in an external direction. Items were dropped on which there was no complete agreement among the judges. This left 59 items which made up the preliminary form of the test. The 59-item form of the test was then given to a sample of children (n = 152) ranging from third through ninth grades. Means for this testing ranged from 19.1, SD = 3.86 at the third grade to 11.6, SD = 4.26 at the ninth grade with higher scores associated with an external orientation. Controlling for IQ, internals performed significantly better than externals on achievement test scores [$t(48) = 3.78$, $p < 0.05$]. Test–retest reliabilities for a 6-week period were $r(98) = 0.67$, $p < 0.05$, for the 8 to 11 year old group and $r(54) = 0.75$, $p < 0.05$, for those in the 12 to 15 year old group,

The 40-item scale was administered to children from the third through the 12th grade to obtain reliability estimates, demographic measures and construct validity information. The sample consisted of 1017 elementary and high school students most of whom were Caucasian. All schools were in a county bordering a large metropolitan school system.

Nowicki and Strickland (1973) present biserial item correlations for males and females at the third, seventh, and 10th grades. The item-total relations are moderate but consistent for all ages. They also reported estimates of internal consistency via the split-half method, corrected by Spearman–Brown $r(99) = 0.63$ (grades 3, 4, 5); $r(117) = 0.68$ (grades 6, 7, 8); $r(125) = 0.74$ (grades 9, 10, 11); $r(54) = 0.71$ (grade 12). The reliabilities may be considered satisfactory because the items are not arranged according to difficulty. Since the test is additive and items are not comparable, the split-half reliabilities tend to underestimate the true internal consistency of the scale. Nowicki (2018b, unpublished[2]) includes internal consistency estimates from other studies that range from 0.60 to 0.70.

Nowicki (2018b, unpublished[2]) reports results of factor analyses of children that suggest the scale has a general "helplessness" factor of about 0.30. Nowicki and Strickland (1973) reported test–retest reliabilities sampled at three grade levels, 6 weeks apart; $r(99) = 0.63$ for third graders, $r(117) = 0.66$ for seventh graders, and $r(125) = 0.71$ for the 10th graders. Nowicki (2018b, unpublished[2]) reported the results of several other studies showing that test–retest correlations ranged from 0.67 over 6 weeks to 0.63 for 9 months.

Discriminative validity

A prime goal of those who construct LOC scales is to keep social desirability at a minimum. Nowicki and Strickland (1973) reported non-significant correlations between LOC scores and social desirability for subjects in grades 3–12. Nowicki (2018b, unpublished[2]) reported results of other studies that also found non-significant associations between CNSIE scores and social desirability. Further data are presented by Nowicki and Duke (1983) and Nowicki (2018b, unpublished[2]).

Construct validity

In terms of convergent validity support for the CNSIE, Nowicki and Strickland (1973) reported data showing significant but moderate relations between the CNSIE and other measures of LOC such as the Intellectual Achievement Responsibility and the Bialer-Cromwell scales. If a measure of a construct such as LOC has been found to be related to other variables in a theoretically consistent fashion, then the measure gains some degree of construct validity for the CNSIE. Nowicki and Strickland (1973) reported externality on the CNSIE was associated in a theoretically consistent manner with lower as opposed to upper social class and non-white as opposed to white participants.

In addition, results of studies support the theoretical assumption that internality is associated with higher and externality with lower academic achievement as well as to those behaviors associated with academic achievement, such as persistence. For example, Nowicki and Strickland (1973) reported significant correlations between internality and higher academic achievement for children from grades three through 12. Others (see Nowicki, 2018b, unpublished[2]) have confirmed the internality, achievement association not only in American but in Danish, Hungarian and Mexican children as well. Nowicki (2018b, unpublished[2]) reported that results from six studies found that internals persisted longer on tasks than externals. Finally, Nowicki (2018b, unpublished[2]) summarized research that showed that externality was associated with a variety of psychological and physical difficulties. Additional support for the construct validity of the CNSIE can be found elsewhere (Nowicki and Duke, 1983; Nowicki, 2016; Nowicki, 2018b, unpublished[2]).

The CNSIE form used in the present study originated from an administration of the 40-item test to a sample of 120 8 year-old-children and the 12 items with the best item-total correlation were chosen for inclusion in the final form administered to ALSPAC children when they were tested at 8 years of age. The questions were read aloud to the child by the examiner to eliminate variance due to reading ability. The child was asked to respond with a yes/no answer. The tester made clear that there were no right or wrong answers and the items reflected how people thought and felt about different things. A similar scale was sent to the study children in a self-completion questionnaire at age 16. Scores were computed adding the number of external type answers; they ranged from 0 to 12 with higher scores indicating greater externality.

Statistical Analyses

Data were used as continuous when calculating correlation coefficients, and as binary when comparing external with internal orientation. For these analyses, an external LOC (ELOC) was defined as a score greater than the median and an internal LOC (ILOC) as equal to, or less than, the median. We chose to dichotomize both the parent and child data into ELOC and ILOC to facilitate easier interpretation of results. Because of the likelihood of collinearity, stepwise logistic regression was used with p to enter of 0.10, rather than multiple linear regression which assumes a linear association. Analyses were repeated for boys and girls separately. Pseudo-R^2 was used as a measure of Goodness-of-fit (GOF).

RESULTS

The basic data for LOC distributions at each time point are shown in **Table 1**. For parents, externality was defined as having a LOC score above the median (4, 4, and 3 for mothers in pregnancy and 6 and 18 years later; and for fathers it was 3 at each time point). The offspring's scores formed approximately normal distributions with medians of 6 at age 8, and 3 at 16 years.

Correlations Between Measures of LOC for the Individual

For 3487 mothers the LOC score was available at each of the three-time points. Correlation coefficients are presented here as they have the advantage of showing the relationships between the LOC measures between the different family members as well as over time. They were 0.55 and 0.54 for comparisons of pregnancy LOC with those 6 and 18 years later respectively. Similarly, the correlation between the measures of the mother at 6 and 18 years was strong (0.56). Although there were fewer fathers with measures at the three-time points (n = 1176), the correlations were equivalent to those found above for the mothers at 0.55, 0.52, and 0.55, respectively. In contrast the correlation between the child's LOC measures at ages 8 and 16 were weak (0.22).

Correlations Between Parents' and Child LOC Measures

The correlations between parental LOC scores at the three ages with the child's LOC scores are shown in **Table 2**. In comparison with the correlations within the parent over time (where the values were strong at $>$ 0.51), the correlations between each parent and child were weak, ranging between 0.14 and 0.20 for mothers and 0.14 and 0.19 for fathers.

Examination of results for boys and girls separately indicated that correlations between maternal LOC and 16-year-old children tended to be slightly higher (range: 0.18 to 0.20) than found for the 8-year-olds, whereas the correlations between paternal LOC pregnancy score tended to be higher with child LOC at 8 (**Table 2**).

TABLE 1 | The means, standard deviations, and medians for the study parents at three-time points, and for the offspring at two time points measured from birth.

Individual	Time-point	*N*	Mean	*SD*	Median
Mother	Pregnancy	12604	4.37	2.11	4
	+ 6 years	8633	3.83	1.99	4
	+18 years	3758	3.48	2.01	3
Father	Pregnancy	8738	3.60	2.30	3
	+6 years	4507	3.28	2.06	3
	+20 years	1855	2.83	1.86	3
Offspring	Age 8 years	6374	5.99	2.08	6
	Age 16 years	4770	3.20	2.12	3

SD, standard deviation.

TABLE 2 | Correlation coefficients between parents and children.

Individual	Time point	Child at 8 years	Child at 16 years	*N*
Mother				1859
	Pregnancy	0.166	0.169	
	6 years	0.142	0.160	
	18 years	0.171	0.203	
Father				726
	Pregnancy	0.193	0.157	
	6 years	0.160	0.189	
	20 years	0.142	0.143	

Contributions of Parental Externality to Child Externality

Ways in which the binary estimates of the externality of the parents contribute toward the externality of the child are shown in **Table 3**. When all children are considered together, the externality of each parent at each of the two antecedent time points can be seen to be independently associated with the externality of the child. However, if the factors are considered separately for boys and girls, the patterns of association tend to differ: for boys there is no longer an association with paternal ELOC at 6 years; for girls, there is no longer an association with maternal ELOC in pregnancy, and the strongest association is with the fathers' ELOC at 6 years.

Contributions of Parental Externality to Adolescent Externality

Unadjusted odds ratios provide the difference between the straightforward results for external compared with internal individuals; adjusted odds ratios compute the difference after taking account of the other factors that may explain the relationship. For the risk of the 16-year-old being externally oriented, we first present the unadjusted odds ratios [95% confidence intervals], then the results of stepwise logistic regression offering the four parent measures (Adjustment A in **Table 4**), followed by the results of offering the adolescents' own externality at age 8 (Adjustment B). Each of the five unadjusted measures were significantly associated with the adolescents' externality; on adjustment A maternal ELOC in pregnancy dropped out, and in adjustment B paternal pregnancy ELOC also failed to enter – leaving the final model with the parental measures at 6 years, together with the child's own measure at 8. Slightly different results were found for girls when considered on their own: maternal ELOC in pregnancy entered instead of the measure at 6 years (**Table 4**).

DISCUSSION

The following summary of the results provides a foundation for the discussion to follow. Using a comparison of correlation coefficients, the present study found: (1) there was stronger evidence for continuity of parents' LOC over time than there was for their offspring; (2) the correlations between the parents' LOC and that of their offspring were significant but low at both 8 and 16 years of age. Further analysis categorizing external from internal individuals showed that: (3) each external parent was associated with an independent increased risk of their 8-year-old offspring being external, but the increased risk was <50%; (4) each parent who was external when the child was aged 6 was independently associated with the child's LOC at age 16; (5) the external child at age 8 was at increased risk of being external at age 16 independent of the contribution of their parents' LOC; (6) there were differences between the sexes in the patterns of association – *mothers with an external orientation at 6 years were associated with the externality of their sons* at *both* age 8 and age 16 while for the fathers *externality at 6* was associated with *their daughters' externality* at both age 8 and age 16; (7) in addition, for predicting *boys' externality at 8,* the loci of control of both parents were significantly associated, while for predicting *girls' externality*, the external outlook of fathers' prenatally and of mothers at age 6 were associated; (8) finally, for boys' *externality at age 16,* fathers' externality at age 6 and the boys' own externality at age 8 were independently associated; while for *girls' externality at age 16*, it was mothers' prenatal externality as well as the girls' externality at age 8 that were the significant predictors.

TABLE 3 | Stepwise logistic regression analyses to determine whether specific parental externalities were independently associated with externality of the 8 year old child.

Individual time point	Unadjusted			Adjusted		
	n	OR[95%CI]	*p*	*n*	OR[95%CI]	*p*
All children						
M – pregnancy	5902	1.46[1.31,1.62]	****	2620	1.31[1.09,1.57	**
M – 6 years	5227	1.48[1.32,1.67]	****	2620	1.23[1.01,1.49]	*
F – pregnancy	4403	1.64[1.45,1.85]	****	2620	1.41[1.18,1.70]	***
F – 6 years	2958	1.55[1.33,1.80]	****	2620	1.30[1.08,1.55]	**
Boys						
M – pregnancy	2960	1.45[1.24,1.68]	****	1958	1.26[1.03,1.55	*
M – 6 years	2660	1.46[1.23,1.72]	****	1958	1.30[1.05,1.61]	*
F – pregnancy	2202	1.59[1.34,1.90]	****	1958	1.45[1.20,1.76]	***
F–6 years	1503	1.40[1.13,1.73]	**		DNE	
Girls						
M – pregnancy	2942	1.47[1.26,1.70]	****		DNE	
M – 6 years	2567	1.50[1.27,1.78]	****	1287	1.29[1.00,1.66]	*
F – pregnancy	2201	1.69[1.42,2.00]	****	1287	1.39[1.08,1.80]	*
F – 6 years	1455	1.73[1.39,2.14]	****	1287	1.58[1.22,2.04]	***

*GOF for each analysis = 2.13 for all children, 1.51 for boys and 2.38 for girls. DNE, did not enter; F, father; M, mother; p-values: * < 0.05; ** < 0.01; *** < 0.001; **** < 0.0001.*

TABLE 4 | Stepwise logistic regression analyses to determine whether specific parental externalities were independently associated with externality of the 16 year old offspring, first analyzing just for parental ELOC (model A), and then additionally for the child's ELOC at age 8 (model B).

Individual time point	Unadjusted			Adjusted (A)		Adjusted (B)	*B*
	n	OR[95%CI]	*p*	OR[95%CI]	*p*	OR[95%CI]	*p*
All children							
M – pregnancy	4441	1.65[1.45,1.87]	****	DNE		DNE	
M – 6 years	4033	1.69[1.47,1.94]	****	1.59[1.30,1.94]	****	1.43[1.14,1.79]	**
F – pregnancy	3473	1.54[1.34,1.77]	****	1.26[1.03,1.54]	*	DNE	
F – 6 years	2485	1.75[1.48,2.08]	****	1.54[1.26,1.88]	****	1.56[1.28,1.92]	****
Child at 8	3283	1.79[1.54,2.06]	****	–		1.58[1.29,1.93]	****
				(*n* = 2227; GOF = 2.32)		(*n* = 1818; GOF = 2.51)	
Boys							
M – pregnancy	1826	1.45[1.18,1.79]	***	DNE		DNE	
M – 6 years	1707	1.59[1.28,1.98]	****	1.61[1.19,2.18]	**	1.83[1.28,2.61]	***
F – pregnancy	1452	1.46[1.17,1.83]	***	DNE		DNE	
F – 6 years	1083	1.88[1.44,2.44]	****	1.75[1.34,2.30]	****	1.75[1.28,2.40]	***
Child at 8	1377	1.77[1.41,2.23]	****	–		1.56[1.14,2.14]	**
				(*N* = 1064; GOF = 2.26)		(*N* = 793; GOF = 3.66)	
Girls							
M – pregnancy	2615	1.74[1.48,2.04]	****	1.38[1.07,1.78]	*	1.43[1.09,1.89]	*
M – 6 years	2326	1.74[1.46,2.09]	****	1.29[0.99,1.70]	(*)	DNE	
F – pregnancy	2021	1.57[1.31,1.88]	****	DNE		DNE	
F – 6 years	1402	1.66[1.33,2.07]	****	1.56[1.24,1.95]	***	1.47[1.13,1.92]	**
Child at 8	1906	1.77[1.47,2.14]	****	–		1.63[1.25,2.12]	***
				(*N* = 1372; GOF = 1.97)		(*N* = 1028; GOF = 2.48)	

*DNE, did not enter; F, father; M, mother; p-values: (*) < 0.10; * < 0.05; ** < 0.01; *** < 0.001; **** < 0.0001.*

Parent and Child Locus of Control

Parent LOC was associated with their children's LOC, but only in a very limited manner at either point in time, regardless of which pairings were used, be they of same gender, mother prominent, or father prominent. Correlations ranged from near zero to the low 0.20s indicating that other factors besides parent LOC are involved in determining children's orientation.

Although modest in size there was a pattern of differences depending on the sex of the child and the gender of the parent that, to a certain extent, supported the dominant parent prediction, but *across* genders not *between* them. *Mothers*' externality at 6 years was independently associated with *boys*' *externality* at both age 8 and age 16 while *fathers*' externality at 6 years was significantly related to girls' LOC at both testing periods. The finding of significant, cross parent, child LOC associations suggests that parents of the opposite sex of the child may be having an impact on establishing LOC orientations in their children either by more clearly modeling LOC behaviors or through interactions with the child that reinforce the child's own LOC. Observational research of actual parent child interactions could provide evidence to support these or other possibilities (see Carton et al., 1996).

Identifying antecedents of children's LOC appears to be more complex than children modeling the LOC of their parents. The relatively low parent, child LOC associations suggests that researchers need to search for other possible intervening variables involved in the development of LOC. Rotter (1966) and Lefcourt (1976) both theorized that the accurate perception of connections between behaviors and outcomes could be learned: (1) through the use of contingent reinforcement in which the behavior outcome sequence is reinforced by others at the time of its occurrence, or (2) via modeling in which children have opportunities to observe internal or external behavior in their parents and develop internal or external expectancies of their own in response. However, data concerning the presence or absence of contingent reinforcement sequences and/or the degree to which parents actually display behaviors associated with their LOC orientation are lacking in past studies and in the present one as well.

To evaluate the modeling hypothesis, it would be important to know how often and how well parents display clear and explicit examples of internality or externality. Operationalizing behavioral attributes of LOC such as delay of gratification, responsibility, persistence, resistance to coercion or information gathering would be helpful in this effort. Up to now, most researchers have simply assessed parent LOC and assumed they raised their children consistent with their orientation and children somehow "pick up" parents' tendency to behave in internal or external ways and in turn are motivated to model them. The present study found a significant but small association between parent and child LOC, suggesting there is much more to learn about what else parents do to facilitate the learning of internal/external control expectancies in their offspring.

After reviewing the literature concerning antecedents of LOC, Carton and Nowicki (1994) recommended that researchers gather more observational information about how parents

interact with their children across the full range of control expectancies. They suggested use of the concept of "goodness of fit" as one way to better gauge the learning environment of children. For example, certain types of children's temperament may "fit" better with internal as opposed to external parent LOC. The better the "fit" the better are conditions for learning the connection between behavior and consequences. On the one hand, for example, it could be predicted that children with temperaments that would be easier for parents to deal with would be more likely to learn the behavior consequence sequences necessary for developing internality. On the other hand, it also could be predicted that children whose temperaments command more time, attention, and focus from parents may be the ones to elicit more behaviors associated with the parents' LOC resulting in a higher parent, child LOC association. More research is needed to clarify parents' role in children's LOC.

Stability of Locus of Control Across Time: Adults

Locus of control in adults between early to middle adulthood, appears to be relatively stable from before the child was born to when the child was aged 6 and 18–20. Correlations in the 0.50s for both mothers and fathers across all measurement points suggest consistent stability that didn't seem differentially affected by the birth of the child. Correlations in the 0.50s, though significant, still leave considerable variance unaccounted for, and indicate that many women and men changed their LOC orientation over time. It would be helpful to know what events were associated with stability and changes toward internality or externality. Such information could provide valuable insights into how control expectancies are learned, which in turn could be used to develop interventions to change LOC.

Researchers have identified some factors associated with change in adult LOC as measured by the present tests. Nowicki et al. (2018a) found parent LOC change over 6 years to be associated with the type and number of stressful experiences involving *relationships*, *health,* and *finances*. These findings are consistent with those found using other LOC tests. For example, Elkins et al. (2017) found that long term difficulties rather than single events appeared to be associated with changes in LOC as measured by items from Pearlin and Schooler's Mastery module. In addition, other research (Nowicki et al., 2018b) found that changes toward greater parent externality were associated with children having more teacher reported difficulties, while transitions to greater parent internality were characterized by fewer ones.

Stability of Locus of Control Across Time: Children

Children's LOC scores are less stable than those of their parents. Children's emotional, physical, and cognitive abilities are changing more quickly and extensively than their parents. Based largely on past cross-sectional findings, children's LOC appeared to become more internal during childhood and into adolescence. However, there are scant data from longitudinal studies to confirm this trajectory within children over time. Although the mean LOC scores of children was more internal at age 16 than at age 8, the correlations between the two ages is only 0.23, revealing significant intra-and inter-child change between the two testing times. In contrast to cross-sectional data which suggest stable movement toward internality during childhood, our longitudinal data suggest considerable volatility and change in children's LOC between the ages of 8 and 16. Because of its relative instability, finding factors associated with stability and change in children's LOC are important and should be identified.

Limitations

Although this study is limited by the gaps between measures of LOC, it is unique in having longitudinal data with a large population sample, utilizing trios of mothers, fathers, and their children. The major limitation is a greater loss of external than internal participants over time.

CONCLUSION

The present study is among the first to establish consistency of adult LOC scores beginning before children were born and extending for two decades, and child LOC extending from childhood into adolescence using standardized and construct valid tests tied to Rotter's definition. Adults' LOC scores are significantly more consistent than children's. We also found a significant, but small, correlation between parent and child LOC and suggested that other factors, such as child temperament and time parents and children interact, may be associated with the development of control expectancies. We urge future researchers to focus on gathering observational information concerning parent, child interactions, and operationalizing parent behavior that reflects their control expectancies.

AUTHOR CONTRIBUTIONS

SN had the idea. JG planned the analyses. GE and SG undertook the statistical analyses. JG and SN wrote the first draft. All authors contributed equally to writing later drafts, checking, and editing.

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Early Home-Life Antecedents of Children's Locus of Control

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Children's external locus of control has been linked to a wide variety of negative academic achievement, personality, and social adjustment outcomes. The purpose of this study was to discover which features of early home environment may facilitate the development of external as opposed to internal control expectancies in children. We use an exposome approach to analyze data from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort study, a longitudinal study starting in pregnancy in England in 1990–1992. Details of parents and their study children were collected prospectively, and children's locus of control was assessed at age 8 using an abbreviated form of the most frequently used measure of children's locus of control (Nowicki-Strickland Internal External locus of control scale). A series of stepwise logistic regression analyses were undertaken to determine the strongest independent associations. The final model (n = 4,075 children) comprised 13 variables – those with the strongest associations with the child becoming externally oriented were two that were positive indicators of the mother being distracted (TV on almost the whole time, and a consideration that pets should be treated as members of the family), three that were indicators of protective (negative) effects of interaction between mother and child (child was breast fed, mother read stories to the child, mother cuddled the baby when he/she woke at night), and two divergent indicators of maternal health behavior (more frequent cleaning of the child's hands before a meal which was associated with a heightened risk of become external, and providing a healthy-type of diet, which was associated with a reduced risk of becoming external). The findings suggest that inadequate early maternal interaction with the child is associated with an increased risk of the child being externally oriented by the age of 8.

Keywords: ALSPAC, longitudinal cohort, child locus of control, parent locus of control, parent–child interaction

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INTRODUCTION

The purpose of the present study is to explore possible antecedents in the development of locus of control. Locus of control was introduced by Rotter (1966) and he defined it as follows. "Internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may

generalize along a gradient based on the degree of semantic similarity of the situational cues." (p. 1).

Rotter's introduction of the locus of control construct stimulated the publication of thousands of studies (Nowicki and Duke, 1982, 2016; Nowicki, 2017) the results of which suggest being more, rather than less, externally controlled is associated with negative outcomes.

While a complete review of locus of control results is beyond the scope of the present paper, Crandall and Crandall (1983) summarized the considerable research results gathered in the two decades following the introduction of locus of control by Rotter:

> ". . .perceptions of internal control, compared to perceptions of external control, are generally found to facilitate: (a) more active search of the environment for information relevant to salient goals, superior cognitive processing and recall of that information, and more incidental as well as intentional reaming; (b) more spontaneous engagement in achievement activities, selection of more challenging tasks, and better ability to delay gratification and to persist under difficulty; (c) higher levels of academic and vocational performance and more positive achievement-related attitudes; (d) more attempts to prevent and remediate health problems; (e) better interpersonal relationships, more assertiveness toward others, and more liking and respect from others, despite greater resistance to their influence; and (f) better emotional adjustment (higher self-esteem, better sense of humor, less anxiety, less depression, less severe psychiatric diagnoses, etc.) and greater reported life satisfaction and contentment." (pp. 53–54).

More recent research results have provided support for Crandall and Crandall's summary. More specifically, for example, higher external locus of control was associated with increased chances of being suicidal (Liu et al., 2005), depressed (Benassi et al., 1988; Luthar and Blatt, 1993; Garaigordobil et al., 2017), less persistent in completing tasks (McLeod, 1985), rejected by peers (Sandstrom and Coie, 1999), bullied by peers (Radliff et al., 2016), lonely (Doman and Roux, 2010), anxious (Rawson, 1992; Nanda et al., 2012; Ollendick and Grills, 2016; Chorpita et al., 2017), overly aggressive (Jung et al., 2018), academically less successful (Coleman et al., 1966; Kalechstein and Nowicki, 1997; Schelhas et al., 2012; Becares and Priest, 2015; Amata et al., 2017), lower in self-esteem (Wickline et al., 2011) and more anxious and depressed when suffering from Tourette's syndrome (Cohen et al., 2008).

Because most research evidence suggests the disadvantage of being more rather than less external, the importance of knowing the antecedents that precede the development of external control expectancies is a priority.

What Rotter and Others Suggested Were Antecedents of Locus of Control

Rotter (1966) assumed that learning "contingencies" between behavior and outcomes was at the heart of developing appropriate internality and theorized: (a) a generalized expectancy of internal control develops when reinforcement was perceived as contingent on the individual's behavior; (b) once an expectancy is established, "reinforcement acts to strengthen an expectancy that a particular behavior or event will be followed by that reinforcement in the future and failure of the reinforcement to occur will reduce or extinguish the expectancy." (p. 2). For Rotter, parents provide the primary source for contingency learning in their young children via "consistent discipline and treatment during their time together." (p. 24).

Lefcourt (1976) also points out that parents are in a prime position to facilitate or hinder the contingency learning process. He believed warm supportive parents help to make children feel safe and secure enough to explore their environments and learn how their behavior connects to outcomes across a variety of situations; internal control expectancies can develop and generalize from such experiences. In contrast, parents who neglect or reject their children may be more likely to produce anxiety that interferes with learning connections between behavior and outcomes and constricts the number and quality of children's interactions with the physical and social environments.

For the most part, research is supportive of Rotter and Lefcourt's views. Carton and Nowicki (1994) reviewed the antecedent literature and concluded that: "Children with generalized internal, as opposed to external, control expectancies report less stress earlier in their lives and have parents who report treating them more consistently, granting them greater autonomy to pursue their activities earlier, and providing them with a warm, supportive relationship." (p. 139).

However, Carton and Nowicki (1994) go on to criticize the field's use of cross-sectional, self-report methodologies with small samples of non-representative participants and suggested large scale prospective cohort approaches with representative populations could obtain more valid data to support or refute what has been found previously regarding antecedents of locus of control. The present paper is an attempt to carry Carton and Nowicki's recommendation forward.

The Present Study

Early experiences in the home may set the tone for children's ability to pick up the relevance between their behavior and outcomes. Past research has typically used retrospective or correlative methodologies to gather general information about parent disciplinary practices or children's view of parents' actions. Few have looked at the specific everyday activities within the home, especially before the age of five, to get a sense of the "nuts and bolts" of the typical home environment's ability to favor or hinder behavior, outcome contingency learning. While maternal factors will be a primary focus, we use an exposome approach to uncover relevant factors associated with children's locus of control prior to their fifth birthday.

It should be noted that the data presented form a unique resource in that they are prospectively collected from a large population cohort which has measured the locus of control of both parents and children over time. An additional advantage concerns the large number of different variables collected

which measure the domestic environment and parenting behaviors.

MATERIALS AND METHODS

Participants

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a pre-birth cohort designed to determine the environmental and genetic factors associated with the development and health of the children born to the women recruited in pregnancy (Golding and Alspac Study Team, 2004; Boyd et al., 2013; Fraser et al., 2013). As part of the study design there was a concerted effort before the child's birth to obtain from the parents details of their personalities, moods and attitudes, including a measure of their locus of control (LOC). LOC scores were then measured in the children at ages 8 and 16.

ALSPAC recruited 14,541 pregnant women residents in Avon, United Kingdom with expected dates of delivery between 1st April 1991 and 31st December 1992. This was an estimated 80% of the eligible population. Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14,062 live births, 13,988 of whom were alive at 1 year of age. Data were collected at various time-points via self-completion questionnaires, biological samples, hands-on measurements, and linkage to other data sets. Please note that the study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool: http://www.bristol.ac.uk/alspac/researchers/our-data/.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee (ALEC) [ALEC; IRB00003312] (registered on the Office of Human Research Protections database as UBristol IRB #1) and the Local Research Ethics Committees. ALEC agreed that consent was implied if questionnaires were returned. Informed written consent was obtained for all biological samples prior to analysis, and for certain invasive procedures during the hands-on assessments. The hands-on assessments carried out on a random 10% of the children aged <5 years and the full cohort at ages 7 onward were optional to attend and each individual measure in these clinics was also optional and only carried out with signed consent from a parent and assent from the child (Birmingham, 2018).

Following advice from ALEC, the fathers were not enrolled directly, but involved by sending questionnaires to the mothers to pass on to them if they wished, with a separate reply-paid envelope. The study deliberately had no information on whether the mother had invited her partner to take part except when the completed questionnaire was returned. In consequence of this protocol, there was no way in which the study could send reminders directly to the partners. However, 76% of the partners returned their questionnaires during the pregnancy.

The study population has been shown, by comparison with the 1991 Census, to be approximately representative of the area, and of the United Kingdom population in general. It should be noted, however, that at this time the proportion of non-white children in England was low (∼6%), and was only ∼5% of ALSPAC children. Just 5% of mothers were teenagers at the time of birth, and a further 19% were under 25; 10% were 35 or over. The

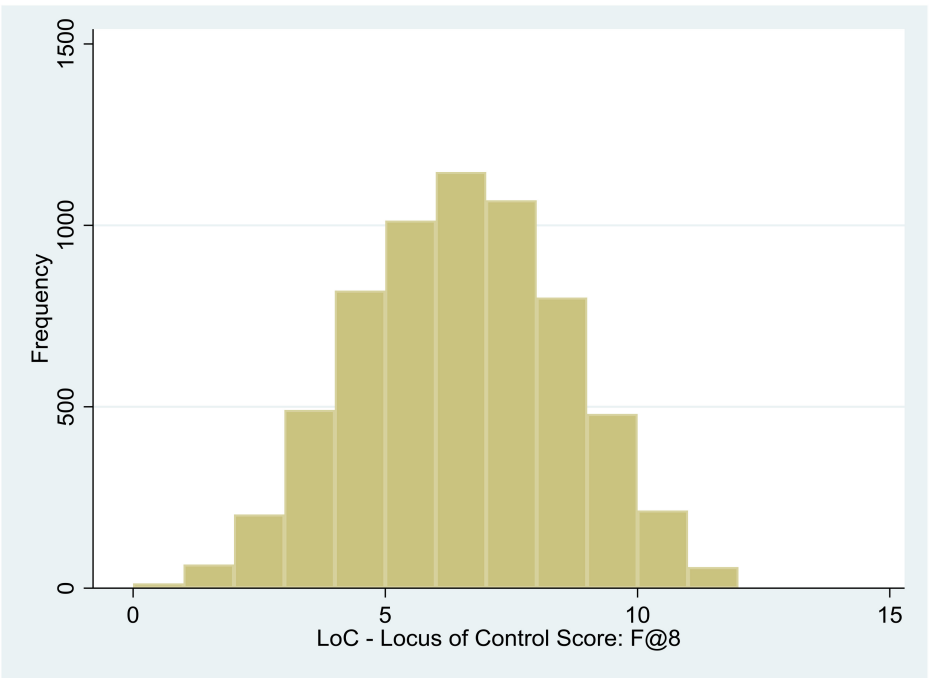

FIGURE 1 | Histogram showing the distribution of children's locus of control scores at age 8.

TABLE 1 | Variation in proportion of children who became external according to early home environment experiences.

	Proportion (*n*) who became external	*p*
Lives in public housing at 8 months		
Yes	54.2% (272)	
No	38.9% (2228)	<0.0001
Crowding (persons/room) at 21 months		
<0.5	33.8% (425)	
0.5–0.99	40.7% (1344)	
1.00+	44.8% (546)	<0.0001
Passive smoke exposure at 15 months		
Yes	46.7% (1045)	
No	36.6% (1455)	<0.0001
Pets in home at 8 months		
Yes	42.8% (1428)	
No	37.6% (1086)	<0.0001
Dog in home at 8 months		
No	39.0% (1949)	
Yes	45.9% (565)	<0.0001
Mother believes pets should be treated as family		
Yes	49.3% (578)	
No	37.7% (1717)	<0.0001
Child cleans hands before meals at 15 months		
Always	46.5% (329)	
Usually	41.7% (916)	
Sometimes	38.2% (727)	
Occasionally	38.2% (393)	
Never	35.4% (127)	<0.0001
Child swallows toothpaste at 2 years		
Yes	37.0% (1244)	
No	43.6% (1124)	<0.0001
TV on most of the day at 30 months		
Yes	46.7% (1240)	
No	35.1% (954)	<0.0001
Time child spent watching TV per week at 3 years		
0–3 h	32.8% (67)	
3.5–6 h	36.0% (705)	
6.5–9 h	40.6% (986)	
>9 h	46.3% (630)	<0.0001
Changed carer between ages 18 and 30 months		
Yes	28.8% (127)	
No	41.2% (2297)	<0.0001

proportion of mothers with University degrees was 14%, and a further 14% had very low or no scholastic qualifications. The study area included the city of Bristol as well as smaller urban and semi-urban areas, as well as rural communities.

Outcome Measure

The children's locus of control measure used in the present study was an adaptation of the Children's Nowicki Strickland Internal External scale (CNSIE, Nowicki and Strickland, 1973) The CNSIE has been used in hundreds of studies that have provided data supportive of their construct validity. The full CNSIE, comprising 40 questions, was administered to a sample of 120 eight-year-old children and the 12 items with the best item-total correlation were chosen for inclusion in the final form. This form was administered to ALSPAC children when they were tested at 8 years of age. Examiners read LOC questions out loud to the child (to control for reading ability) as part of the tests that were undertaken in a clinic specially designed to test the children physically and psychologically. The child was asked to respond with a yes/no answer. It was made clear by the tester that there were no right or wrong answers and that we were just interested in knowing how different people think and feel about different things; in addition, the children were reminded that their answers were confidential.

The Exposome Strategy

We first use a hypothesis-free approach to identify factors that are associated with childhood externality by assessing the association of this binary variable with 1355 variables associated with exposure of the child in the preschool phase (<5 years). These include facets of labor and delivery (35 variables), diet and nutrition (532), sleeping conditions (41), aspects of child care and parenting (155), equipment and toys available (49), social and housing circumstances (362), pets, pests and hygiene (112), life events to the child (44) and other miscellaneous features (25). The variables are frequently not independent of one another: for example, the same exposure may be considered at several different ages. The following strategy was therefore used: (a) unadjusted associations with $P < 0.0001$ were selected ($n = 247$); (b) those variables measuring similar features were examined and a selection was made based on the validity of the variable, the amount of missing data and the effect sizes. The full set of 1,355 associations with odds ratios and 95% confidence intervals are available from the corresponding author.

The remaining variables are described in the **Appendix**. They were arbitrarily formed into three logical groups as described in the Results section. First backward stepwise logistic regression was used with each group to identify which variables were independently associated with the child having an external LOC. Finally, the independent factors within each group were combined and a further backward logistic regression was undertaken to determine a final model. Comparisons of the goodness of fit (GOF) employed the pseudo R^2 statistic, the higher the value the better the fit.

RESULTS

The 12 questions comprising the child's LOC score were completed by 6,381 of the 8-year-old children. The distribution of the LOC scores was approximately normal (**Figure 1**), with median of 6 and 41.2% defined as External (i.e., score > median).

Early Home Environmental Experiences

The 11 dominating environmental variables that were associated with the child becoming external are shown in **Table 1**. The children living in public housing and those in homes with over-crowding were more likely to become external, as were those where the children were frequently in rooms where people were smoking. Unexpectedly there were also positive associations with the presence of a pet in the home, especially of a dog; the mothers who declared that pets should be treated as members of the family were more likely to have a child with an external orientation. Conversely, those whose chief caretaker had changed between ages of 18 and 30 months were more likely to be internal, but those who had their hands cleaned before a meal and those who did not swallow toothpaste were more likely to be external. Finally, there were two variables denoting television in the home: where there was a TV on most of the time, the child was more likely to become external, and there was a strong trend with the amount of time the child watched television at age 3, the more time spent watching the more likely to be external.

The 11 variables were offered to a stepwise logistic regression analysis – three dropped out: the crowding variable at 21 months, whether there were pets in the home at 8 months, and the amount of time the child watched TV at 3 years (**Table 2**).

Early Parenting

There were nine parenting variables with strong associations with subsequent risk of the child having an external orientation (**Table 3**): only two had a positive association however (a grand-parent looking after the child, and the mother slapping him/her were both associated with the child being external). The apparently protective factors were cuddling the baby when awake in the night; using a baby sling at 8 months; having paid child care; taking the child to a library or place of interest at 30 months; singing and/or reading to the child at 2 years. Stepwise logistic regression analyses using these nine variables resulted in three dropping out: paid child care; the mother singing and the child going to a library (**Table 4**).

Dietary Practices

In all, 11 variables related to diet or related behaviors (**Tables 5A,B**). Those that were associated with the child being more likely to be internal were: the length of time before the newborn baby was put to the breast; whether breast fed in the first month of life; whether fed on demand; whether being given a traditional type of diet; and/or one that used foods assumed to be healthy. Conversely, the following were predictive of the child being external: the mother stating that she had loved the baby immediately; the child being given a dummy (comforter or pacifier) in the first month of life; having formula by 6 months of age; having tea and/or cola to drink regularly in the period 6–15 months; and having a diet largely dominated by processed foods.

When these 11 variables were offered to stepwise logistic regression, those that dropped out were being breast fed in the first month; being fed on demand, having formula by 6 months of age and being given cola to drink in the period from 6 to 15 months of age (**Table 6**).

The Final Model

Offering the variables that survived each of the inter-group analyses (**Tables 2**, **4**, **6**) to a stepwise regression, the following eight variables dropped out: living in public housing, child swallowing toothpaste, and changed carer between 18 and 30 months, mother used a baby sling at 8 months, grandparents look after the child at 8 months, child is taken to places of interest at 30 months, mother said that she loved the child immediately after the birth, and that she used a dummy in the first month of life. Thirteen variables comprised the final model (**Table 7**). Of these, those that were particularly strong (arbitrarily defined as $P < 0.01$) were the following predictors of externality in the child: maternal belief that pets should be treated as members of the family; frequency with which the child's hands are cleaned

TABLE 2 | Aspects of early child's social conditions related to the child having an external LOC at age 8: all children.

Social conditions	Unadjusted			Adjusted		
	n	OR [95% CI]	*p*	*n*	OR [95% CI]	*p*
Council accommodation 8 months	6219	1.86 [1.54, 2.29]	<0.001	4606	1.38 [1.09, 1.75]	0.008
Persons/room 21 months	5770	1.15 [1.09, 1.21]	<0.001		–	
Exposed to passive smoke 15 months	6211	1.51 [1.36, 1.68]	<0.001	4606	1.29 [1.13, 1.46]	<0.001
Household owned pets 8 months	6222	1.24 [1.12, 1.37]	<0.001		–	
Owned a dog	6222	1.33 [1.17, 1.51]	<0.001	4606	1.24 [1.06, 1.44]	0.006
Mother belief in pets as family	5722	1.37 [1.27, 1.47]	<0.001	4606	1.20 [1.10, 1.32]	<0.001
Child's hands cleaned before meals	6192	1.17 [1.09, 1.25]	<0.001	4606	1.11 [1.03, 1.21]	0.010
Child swallows toothpaste	5938	0.76 [0.68, 0.84]	<0.001	4606	0.85 [0.75, 0.97]	0.012
TV on most of the day 30 months	5610	1.65 [1.48, 1.84]	<0.001	4606	1.54 [1.36, 1.74]	<0.001
Time child spent watching TV 3 years	5953	1.05 [1.03, 1.06]	<0.001		–	
Changed carer from 18 to 30 months	6014	0.58 [0.47, 0.72]	<0.001	4606	0.71 [0.57, 0.91]	0.006

GOF = 2.89.

TABLE 3 | Variation in proportion of children who became external according to early parenting experiences.

	Proportion (*n*) who became external	*p*
Baby was cuddled when woke at night		
Always	35.5% (517)	
Usually	38.8% (380)	
Sometimes	43.1% (868)	
Never	41.7% (613)	<0.0001
Grandparent looked after child at 8 months		
Yes	43.2% (1227)	
No	37.7% (1250)	<0.0001
Paid child care at 8 months		
Yes	33.3% (256)	
No	41.2% (2221)	<0.0001
Child is taken to a library at 30 months		
Yes	35.4% (827)	
No	43.3% (1582)	<0.0001
Child taken to places of interest at 30 months		
Yes	36.2% (1202)	
No	45.2% (1214)	<0.0001
Mother sings to child every day		
Yes	38.2% (1406)	
No	44.9% (1030)	<0.0001
Child is read to by mother every day		
Yes	35.4% (1377)	
No	48.5% (1051)	<0.0001
Mother slaps child		
1+ times/week	44.3% (785)	
Rarely	40.3% (1183)	
Never	34.6% (463)	<0.0001
Mother used baby sling at 8 months		
Yes	36.2% (1168)	
No	44.6% (1356)	<0.0001

before a meal; the television being on for all or most of the day; and the fact that the newborn baby was never put to the breast. Strong protective factors were the mother cuddling the baby when he/she woke at night; reading to the child at age 2; and having a healthy-type of diet at 2 years.

DISCUSSION

While in some ways parent locus of control might have been expected to be a relevant antecedent of children's orientation, past research suggests otherwise. A previous study using ALSPAC data found correlations between parent and child locus of control ranged from 0.14 to 0.19. (Nowicki et al., 2018b) The low parent, child correlations suggest other factors are at play in developing children's locus of control orientations especially during their early years spent largely in the home. In order to investigate what factors may be having such an influence this study has used a hypothesis free approach to uncover features of the child's first 5 years of life associated with him/her being more externally oriented at 8 years of age. As suggested by the literature, indicators of a warm nurturing background (breast feeding; cuddling when waking at night; being read stories) were related to being less external, whereas indicators of maternal interests such as being less focused on the child (having the TV on almost all day; believing pets should be treated as equal parts of the family) were positively associated with the child being more external.

Rotter (1966) and Lefcourt (1976) theorized that greater maternal distance and lack of attention would hinder children's ability to learn which aspects of their behavior were contingent with what happens to them and, in essence, that is what we found in the present study. External mothers showed indicators that they were less likely to develop close and nurturing relationships with their children (for example, putting family pets on an equal footing with their children in terms of attention). Our methodology did not allow us to observe what actually occurred during the interactions between mothers and their young children, however the findings of children having reduced time with and attention from their mothers is consistent with the idea that less contingent learning may be taking place which in turn may produce greater externality. This possibility is supported by the work of Carton et al. (1996). They observed the interactions between mothers and their children on a series

TABLE 4 | Aspects of early child's parenting related to the child having an external LOC at age 8: all children.

Aspects of parenting	Unadjusted			Adjusted		
	n	OR [95% CI]	*p*	*n*	OR [95% CI]	*p*
Cuddles baby when wakes at night	5918	0.86 [0.81, 0.92]	<0.001	4690	0.89 [0.83, 0.95]	0.001
Grandparent looks after child 8 months	6149	1.26 [1.14, 1.39]	<0.001	4690	1.15 [1.02, 1.30]	0.022
Paid childcare at 8 months	6150	0.71 [0.61, 0.84]	<0.001		–	
Child goes to library 30 months	5990	0.85 [0.81, 0.89]	<0.001		–	
Visits to places of interest 30 months	6010	0.79 [0.74, 0.84]	<0.001	4690	0.92 [0.85, 0.99]	0.029
Mother sings to child daily 2 years	6068	0.83 [0.74, 0.92]	<0.001		–	
Stories read to child at 2 years	6056	0.74 [0.69, 0.79]	<0.001	4690	0.80 [0.74, 0.86]	<0.001
Child slapped by mother 2 years	6044	1.18 [1.12, 1.24]	<0.001	4690	1.08 [1.01, 1.14]	0.023
Mother uses baby sling at 8 months	6245	0.70 [0.64, 0.78]	<0.001	4690	0.86 [0.76, 0.98]	0.020

GOF = 2.59.

TABLE 5A | Variation in features of feeding of infant and child with their subsequent LOC at age 8.

	Proportion (*n*) who became external	*p*
Time after delivery until first put to breast		
<1 h	36.9% (1333)	
1+ h	41.3% (685)	
Not put to breast	51.0% (541)	<0.0001
Mother loved baby immediately		
Yes	41.6% (2073)	
No	35.9% (480)	<0.001
Any breast feeding in the first month		
Yes	38.3% (2052)	
No	51.3% (554)	<0.0001
Fed on demand in the first month		
Yes	38.0% (1756)	
No	47.0% (840)	<0.0001
Baby used a dummy in first 4 weeks		
Yes	43.6% (1549)	
No	36.6% (1057)	<0.0001
Given formula in first 6 months		
Yes	41.6% (2107)	
No	35.0% (438)	<0.0001
Drank tea 6–15 months		
Yes	46.0% (1033)	
No	37.0% (1460)	<0.0001
Had cola 6–15 months		
Yes	47.5% (534)	
No	38.7% (1957)	<0.0001

TABLE 5B | Mean difference in scores [95% CI] of dietary patterns at 2 years (Northstone and Emmett, 2013) in those who became external compared with those who were internal.

	95% CI	*p*
Traditional	−0.15 [−0.20, −0.10]	<0.0001
Processed	+0.18 [0.13, 0.23]	<0.0001
Healthy type	−0.22 [−0.28, −0.17]	<0.0001

of puzzle tasks and found that mothers of externals were more likely to be more intrusive, interfering and off-task than mothers of internals. Additional research is needed to more fully understand what is happening during mother, child interactions not only in the lab, but in the familiarity of their home settings.

Difficulties in Measuring Antecedents

Identifying other antecedents of locus of control besides parent orientations is more difficult than finding antecedents of traditional personality traits. For one thing, although generalized expectancies tend to become more stable with age, they are fluid and open to change in reaction to environmental and behavioral events throughout life. For example, we found that changes in parent orientations were associated with changes in personal relationships and economic events that may also impact on their children (Nowicki et al., 2018a).

For another thing, antecedents of locus of control can change depending on the age and social situation of the child (Nowicki, 2016). If children are in a "fair" environment, one that allows them to learn contingencies between behavior and outcomes, their increasing ability to impact on their environment will lead them to become more internal with age (see Nowicki and Strickland, 1973).

For a third thing, there is no absolute cut off score to determine who is internal or external. Most often, researchers decide internality and externality statistically *post hoc* by dividing the test distribution at an arbitrary point such as the mean or median or into extremes like top third and bottom third. In rare instances, enough individuals are tested at an age to enable the use of scores that reflect something approaching norms (Nowicki, 2017).

The ALSPAC and the 1970 British national birth cohort data sets contain a substantial number of children for whom LOC scores are available and it has allowed us to determine the contribution of child's LOC to a variety of specific outcomes such as obesity in adolescence (Golding et al., 2018) and adulthood (Gale et al., 2008), poor self-rated health at age 30 (Gale et al., 2008), and with poor academic outcomes (Flouri, 2006), thus providing the measure with construct validity.

Strengths and Weaknesses of the Study

Thus, the strengths lie in the large sample size, the population selection, and the fact that detailed features of childhood were collected from pregnancy onward (and thus independent of the child outcome considered). This is the first large prospective longitudinal study to use an exposome type of analysis to determine features of the child's early upbringing in the home that are independently associated with the development of externality in 8-year-old children. As expected it has identified two aspects of the child's life that have not been considered before but fit within the theoretical framework – both are indicators of the child being less than central to the mothers' attention (having a television on almost the whole of the day and the mother having a strong relationship with household pets).

The weaknesses concern the fact that those parents who were externally oriented were less likely to bring their child for examination (and hence less likely for the child to complete the locus of control scale). There is no means of knowing whether their exclusion is more likely to have diminished the true associations rather than exaggerated them. One other possible weakness concerns the fact that we have only considered environmental factors that were present during early childhood, and it may be that influences in early school life may also have influenced the development of the child's LOC. Finally, although this is a substantial population study, with all social strata represented, it is unclear as to whether our results can be translated to a different population or

TABLE 6 | Aspects of early child diet related to the child having an external LOC at age 8: all children.

Child's diet	Unadjusted			Adjusted		
	n	OR [95% CI]	*p*	*n*	OR [95% CI]	*p*
Time before put to breast	6339	1.31 [1.23, 1.40]	<0.001	5326	1.18 [1.09,1.27]	<0.001
Mother loved immediately	6323	1.27 [1.12, 1.43]	<0.001	5326	1.22 [1.06, 1.40]	0.006
Breast fed in first month	6442	0.59 [0.52, 0.67]	<0.001		–	
Fed on demand	6413	0.69 [0.62, 0.77]	<0.001		–	
Used a dummy in first month	6442	1.33 [1.21, 1.48]	<0.001	5326	1.20 [1.07, 1.35]	0.002
Given formula by sixth month	6313	0.76 [0.66, 0.86]	<0.001		–	
Drank tea between 6 and 15 months	6190	1.45 [1.30, 1.61]	<0.001	5326	1.21 [1.07, 1.37]	0.003
Drank cola between 6 and 15 months	6187	1.43 [1.26, 1.63]	<0.001		–	
Had traditional diet aged 2 years	6753	0.85 [0.81, 0.90]	<0.001	5326	0.87 [0.83, 0.93]	<0.001
Diet of mostly processed food 2 years	6753	1.22 [1.15, 1.29]	<0.001	5326	1.14 [1.07, 1.21]	<0.001
Healthy-type diet at 2 years	6753	0.80 [0.75, 0.84]	<0.001	5326	0.84 [0.79, 0.89]	<0.001

GOF = 2.49.

TABLE 7 | The final model predicting the externality of the child at age 8.

Variable	AOR [95% CI]	*p*
Social conditions		
Exposed to passive smoke 15 months	1.17 [1.01, 1.34]	0.034
Owned a dog	1.18 [1.00, 1.39]	0.046
Mother belief in pets as family	1.19 [1.08, 1.30]	<0.001
Child's hands cleaned before meals	1.16 [1.06, 1.26]	0.001
TV on most of the day 30 months	1.37 [1.20, 1.57]	<0.001
Parenting		
Cuddles baby when wakes at night	0.90 [0.83, 0.97]	0.006
Stories read to child at 2 years	0.86 [0.79, 0.93]	<0.001
Child slapped by mother 2 years	1.08 [1.01, 1.16]	0.031
Feeding and diet		
Baby never put to breast	1.13 [1.04, 1.24]	0.007
Drank tea between 6 and 15 months	1.17 [1.01, 1.35]	0.038
Had traditional diet aged 2 years	0.91 [0.85, 0.98]	0.010
Diet of mostly processed food 2 years	1.09 [1.01, 1.18]	0.023
Healthy-type diet at 2 years	0.90 [0.84, 0.97]	0.004

GOF = 4.20; N = 4075. AOR, adjusted odds ratio; CI, confidence interval.

even to a different time period – thus our results need replicating.

CONCLUSION

Evidence is substantial for the association of locus of control with an impressive array of important child outcomes varying from academic achievement to psychological adjustment. Within different age groups, greater externality appears to be associated with more negative outcomes for children. Finding out what may lead some children to be more external than their peers is useful in understanding the dynamics of the acquisition of both external and internal expectancies and in potentially developing interventions to facilitate the growth of appropriate internal expectancies during early childhood. However, there is a lack of concrete information about which aspects of mother–child interactions during preschool years facilitate or hinder the contingency learning so necessary for the development of appropriate internal expectancies. The present study identified some significant mother, child behaviors that were associated with externality in the child. Hopefully future researchers will use other populations to see if these aspects of children's early years in the home are associated with the development of internal and external expectancies.

AUTHOR CONTRIBUTIONS

JG planned and carried out the analyses with SG and GE. SN and JG wrote the first draft of the manuscript. All authors were involved in editing, checking, and rewriting the paper.

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APPENDIX

Here, we describe the variables used in the analyses in this paper, with their background where appropriate. All were selected based on their unadjusted associations with the child's externality at age 8 (see the section "Materials and Methods" for selection criteria).

Early Home Environmental Experiences

(i) Council accommodation (i.e., public housing) - This variable was selected from the question asked on the tenure of the housing in which the child resided. This was asked at 8, 21, 33, and 61 months. The variable at 8 months was selected.

(ii) Crowding: This was calculated as the number of persons in the household divided by the number of rooms used for living or sleeping - this excluded kitchens too small to eat in, bathrooms, etc. The variable was available for 21 and 33 months, and the 21-month variable was selected.

Exposure to passive smoking: This variable was in answer to the question: 'Please indicate how often during the day he/she is in a room or enclosed place where people are smoking. The mother was asked separately for weekdays and weekend days, and was given the following options: 'all the time; more than 5 h; 3, 4 or 5 h; 1 or 2 h; less than 1 h; not at all. For this study no exposure was coded if both the weekdays and weekend days had indicated 'not at all.'

Pets in the household: The mother was asked approximately annually whether there were any pets in the household. Here, we took the answers given when the child was 8 months old.

Dog(s) in the household: This was a supplementary question following the question on pets.

Attitude of mother toward pets: When the child was 33 months old the mother was asked her reaction to the statement: 'Pets should have the same rights and privileges as family members.' And was given the possible responses: 'Strongly agree; Agree; Disagree; Strongly disagree.' Here, the first two and last two responses were combined.

Hands cleaned: When the child was 15 months old, the mother was asked - 'All children get dirty. How often in a normal day . are her hands cleaned before a meal?' Possible responses were: always; usually; sometimes; occasionally; never. For the analyses the third and fourth groups were combined.

Swallows toothpaste: At 2 years a question concerned whether when cleaning his/her teeth the child swallowed the toothpaste or spat it out. The options were: swallows it; spits it out; varies. Here, the answers were dichotomized into those who consistently spat it out and the rest.

Television in the home: There were two questions on the TV that were used. (i) At 30 months the mother was asked: 'When do you have the television on?' and given the options 'all day; most of the day; mornings only; afternoons only; evenings only; not at all; do not have a TV. For these analyses 'all day' and 'most of the day' were combined. (ii) At 3 years she was asked how much time the child spent watching TV per week.

Changed carer: This question was part of a series of potentially life changing events occurring between 18 and 30 months.

Early Parenting Strategies

Cuddling of baby: At 6 months the mother was asked what she did when the baby woke at night. Among the options she was asked how frequently she rocked or cuddled him/her, and given the options: Always; Usually; Sometimes; Never.

Grandparent looked after the child: At 8 months the mother was asked: 'Apart from yourself, who regularly looks after your baby when you are out?' One of the options was the baby's grandparent.

Paid child care: Another option at 8 months was: paid person outside baby's home (e.g., child minder).

Taken to library: At 30 months the mother was asked: 'How often do you take him/her to . a library' with possible options: 'nearly every day; about once a week; once a month; a few times a year; never.' Here, we have combined once a month or more frequently as 'yes' and less than once a month or never as 'no.'

Taken to places of interest: This was part of the same set of questions at 30 months, and the same categorization was used.

Activities with the child: When the child was 2 years, the mother was asked When you are at home with your child, how often do you do the following: and was given the responses: Every day; several times a week; about once a week; rarely; never. Among the activities, was: (i) Sings to child; (ii) Read him/her stories; (iii) Slaps him/her.

Use of baby sling: At 8 months, the mother was asked whether she had a Sling or back pack for carrying the child and was given the possible responses: Yes but not used; yes and used; no, do not have. In this study we distinguish between those who had and used their sling from the remainder.

Dietary Practices: In this section, we include dietary factors as well as two factors that were not strictly dietary (use of dummy/comforter and time taken to love the baby). The actual items used are as follows.

Time after delivery until first put to the breast: This is a measure of breast feeding as well as of the time to the initiation of breast feeding.

Time to love baby: At 4 weeks the questionnaire stated - 'Often mothers are surprised how long it takes to love their babies. How long has it taken you?' The possible responses were: 'I loved him immediately; It took a little while; It took over a week; I still do not love him fully; can't remember.' Here, we compared those who said they loved the baby immediately with the remainder.

Breast fed: This variable considered any breast feeding in the first month of life.

Fed on demand: The mother was asked at 4 weeks - 'Is your baby fed (either by breast or bottle) on a regular schedule (e.g., every 4 h)? And was given the options: yes always; yes try to; no, fed on demand.

Baby used a dummy: At 4 weeks the mother was asked for daytime and for the night - 'Does your baby have a dummy or comforter? Possible responses were: Usually; Often; Sometimes; Never. The variable distinguished the babies that were given a dummy (comforter/pacifier) whether by day or night from those who never used a dummy.

Formula at 6 months: The mother was asked whether the baby had had a bottle of formula by age 6 months.

Tea: At 15 months the mother was asked whether the toddler had had tea to drink.

Cola: At 15 months the mother was asked whether the toddler had had cola to drink.

Dietary patterns: At age 2 years the frequencies of foods and drinks which the child was consuming were used to identify three types of dietary pattern (Nanda et al., 2012):

(i) Traditional diet also called 'family foods.' This was a score that particularly identified traditional British family foods such as meat, fish, puddings, potatoes, and vegetables.

(ii) Processed foods: Many of the food loadings on this pattern were high in sugar such as sweets, chocolate, fizzy drinks, and flavored milks. Other foods associated with this pattern such as crisps, potatoes, baked beans, peas, and soup were foods required little in the way of cooking.

(iii) Healthy-type: This pattern was loaded with foods often recommended as the basis for a healthy diet, such as fruit, vegetables, eggs, nuts, and juices.

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Maternal Prenatal External Locus of Control and Reduced Mathematical and Science Abilities in Their Offspring: A Longitudinal Birth Cohort Study

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A personality scale that identifies individuals' general attitude to what happens to them as largely a matter of luck or fate or of powerful others (externality) or whether they feel they can influence the consequences (internality) is known as locus of control (LOC). A continuous scale can distinguish those who are more external from those who are more internal. Lower scholastic achievement is associated with externality and higher achievement with internality, but little is known about the association of parental LOC on children's academic performance. Data collected within the Avon Longitudinal Study of Parents and Children (ALSPAC) are analyzed to assess associations between mothers' LOC orientation, measured during pregnancy, and their children's abilities in mathematics and science reasoning. We found that maternal external LOC is associated with lower scores for her child assessed by tests measuring mental arithmetic as well as understanding of mathematical and scientific concepts. Additionally, we determined the extent to which three separate sets of factors previously found to positively influence the developing child's ability mediate these findings: (a) perinatal and infant exposures, such as prenatal smoking, binge drinking, consumption of oily fish, and postnatal breast feeding; (b) parenting attitudes and strategies; and (c) the interface of the parents with their child's school. The three factors identify at least 50% of the mechanism by which maternal externality is associated with poor academic outcomes in her child and may be candidates for further investigation as possible intervention targets.

Keywords: ALSPAC, longitudinal cohort, maternal locus of control, numeracy, science, mathematics

INTRODUCTION

As Meadows et al. (2008) have stated: 'Improving numeracy learning has been a dominant educational theme throughout the development of statutory education over the last 100 years or so.' At an individual level, numeracy has a profound effect on overall quality of life, self−identity and the capacity to function in an ever more complex world; and at a macro level, the success of

society depends on a well−educated, numerate and adaptable workforce. However, with the recent advent of the digital age and the need for skilful use of information communications technology, the importance of children becoming proficient with numeracy skills is becoming ever more pressing' (Meadows et al., 2008). Almost equally important nowadays is the parallel development of scientific understanding.

In this paper we attempt to determine a pathway to increased ability in maths and science by assessing ways in which the mother's locus of control (LOC) may influence the child's outcome. Rotter (1966) first introduced the concept of LOC, which he defined as follows: 'Internal versus external control refers to the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics versus the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, fate, is under the control of powerful others, or is simply unpredictable. Such expectancies may generalize along a gradient based on the degree of semantic similarity of the situational cues.'

The introduction of the concept of LOC was greeted positively by both the psychological and educational communities. One of the reasons it has maintained its popularity, as reflected in the well over 17,000 studies that have used it (Nowicki and Duke, 2016), is because of its association with academic achievement. In the same year that Rotter introduced the concept, Coleman et al. (1966) published the results of a national study of half a million students showing their own LOC to be one of the best predictors of their academic achievement. Since that time the LOC, academic achievement association has been examined in many ways, but most often by simply correlating students' LOC orientation with some measure of academic achievement such as grades or standardized tests. Two major reviews (Findley and Cooper, 1983; Kalechstein and Nowicki, 1997) of the LOC, academic achievement association, separated by nearly a decade and a half, came to almost identical conclusions: internally controlled children of all ages did better academically than their externally controlled peers, even when IQ was controlled for.

While most past studies have concentrated on correlating individuals' LOC with some current measure of academic achievement, others have attempted to use LOC to predict future outcomes tied to academic achievement. One example was a study completed by Flouri (2006) who used data from the British Cohort Study (BCS70), a longitudinal study originating in 1970 that included a representative sample of children born in different regions of Great Britain. She found that 10-year-olds' LOC scores as measured by an Anglicized form of the Nowicki-Strickland Internal External control scale (Nowicki and Strickland, 1973), predicted their educational attainment some 26 years later. Taking account of factors such as parental social class, cognitive ability, socioeconomic disadvantage and maternal educational attainment, analyses of the responses of 1,326 men and 1,578 women revealed that their own internality in childhood, along with their mothers' greater interest in their children's achievements, were related to their final educational attainment in both the men and women.

Thus, (1) we know internality is associated with greater academic achievement throughout the lifespan and (2) both mothers' interest in their children's academic pursuits, coupled with the children's internality, predict future academic accomplishment. However, somewhat surprisingly, we know relatively little about the contribution of parents' own LOC orientation to their children's future academic achievement. From what we know about the LOC construct, however, it is likely that parental LOC orientations may affect how they may be able to deal with the everyday challenges of raising their children to be successful academically.

Some help in predicting how the LOC orientation of parents may be associated with the upbringing of their children comes from a summary of study results. Nowicki (2016b) suggests, compared to internals, externals generally: (1) show less persistence in attempting to solve problems, (2) feel less responsibility for their behavior, (3) are rarely relentless in the pursuit of information, (4) cannot tolerate long delays of gratification, and (5) show less resistance to being coerced; characteristics that may not be helpful in attempting to parent successfully.

Based on empirical findings and Rotter's assumptions regarding LOC, we predicted that children whose mothers are more external will: (a) have poorer educational achievements; (b) have relationships between maternal LOC and the child's mathematical and science abilities that will be mediated through maternal lifestyle, parenting behaviors and attitudes to education.

MATERIALS AND METHODS

The Study Sample

This study takes advantage of the data collected as part of the Avon Longitudinal Study of Parents and Children (ALSPAC) a pre-birth cohort which was designed to determine the environmental and genetic factors that are associated with health and development of the study offspring (Golding and ALSPAC Study Team, 2004; Boyd et al., 2013; Fraser et al., 2013).

ALSPAC recruited 14,541 pregnant women resident in Avon, UK with expected dates of delivery 1st April 1991 to 31st December 1992 (an estimated 80% of the eligible population). 14,541 is the initial number of pregnancies for which mothers enrolled in the ALSPAC study had either returned at least one questionnaire or attended a hands-on assessment ("Children in Focus" clinic) by the 19th July 1999. Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14,062 live births and 13,988 children who were alive at 1 year of age. Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, and linkage to other data sets. Please note that the study website contains details of all the data that are available through a fully searchable data dictionary and variable search tool: http://www.bristol.ac.uk/alspac/researchers/our-data/

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees (Birmingham, 2018). Detailed information on the

ways in which confidentiality of the cohort is maintained may be found on the study website: http://www.bristol.ac.uk/alspac/researchers/research-ethics/

The study design included a concerted effort before the child's birth to obtain from the parents details of their personalities, moods and attitudes, including a measure of their LOC. This involved the pregnant women completing four questionnaires during the pregnancy, one of which contained the LOC scale; in parallel they were sent two questionnaires for their partners to complete, one of which included the identical LOC scale.

The LOC 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) comprising 40 items in a yes/no format to assess perceived control (Nowicki and Duke, 1974). This measure 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 1000 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. The 12 questions loaded onto a single factor of general LOC. The 12 questions used are shown elsewhere (Golding et al., 2017b). From the responses a 'LOC score' was derived, the higher the score the more external the LOC. The scores ranged from 0 to 12. For this study, external LOC was defined as having a score greater than the median. This cut-off identified 45.2% of the women and 46.6% of the men as externally controlled (ELOC).

Test–retest reliability was assessed in this study by comparing the results 6 years later. The correlations were strong for both men and women ($r > 0.50$).

Outcome Measures

Mathematical Reasoning

These tests were devised by Nunes and Bryant for the ALSPAC study. Their aim was to assess children's understanding and use of quantitative relations to solve mathematical problems.

Two different Mathematical Reasoning tasks were designed. The one containing 17 items, was given to school-children inYear 4 (N = 5275, mean age 8 years 9 months). Three types of item were included in the Year 4 Mathematics Reasoning Task: additive reasoning items about quantities, additive reasoning items about relations, and multiplicative reasoning items about quantities. The assessments used in Years 6 and 8 included six types of item: additive reasoning items about quantities; additive reasoning items about relations; multiplicative reasoning items about quantities; multiplicative reasoning items involving relations (i.e., proportions); items about spatial reasoning and items about fractional quantities.

The aim of each task was to assess children's reasoning about quantities and the relations between quantities in mathematical problems independently of their computation skills. None of the items in these tests contained difficult calculations; the children had to reflect on the relations between quantities in each item in order to decide how to solve the problem. All the items were presented with the support of drawings; the children could use counting to solve many of the problems if they did not know the number facts that might be used in the solution. All the problems were presented orally by the teachers to avoid an undue influence of reading difficulties on the children's performance (Nunes et al., 2009).

Analyses of their internal consistency using Cronbach's α showed that on all three occasions the mathematics reasoning tasks had good levels of inter-item reliability: 0.74 at Year 4 (N = 5275), 0.89 at Year 6 (N = 7881) and 0.91 at Year 8 (N = 2755). This high internal consistency justifies the addition of all the items into a single score.

Mental Arithmetic

Mental Arithmetic was measured as part of the WISC (Wechsler et al., 1992) intelligence test administered at 8 years by trained psychologists. The raw scores at age 8 years were measured using alternate questions as for the WISC test in general (Golding et al., 2017a). The scores were approximately normally distributed. As reported by Nunes et al. (2012): *"the split-half reliability for 8-year-olds is 0.78 (Wechsler, 1992, p. 60); and the average correlation with the Wide Range Achievement Test Arithmetic Score is 0.62 (Wechsler, 1992, p. 76), which makes this a valid and economical assessment of children's arithmetic knowledge, thus, suited for large-scale studies such as this."*

Scientific Understanding

This used a test designed to examine the child's understanding of the concepts used in science. It was designed by Terezhina Nunes (TZ) and Peter Bryant (PB) to be administered in school (Bryant et al., 2015). This was undertaken in School Year 6 at the same time as the year 6 maths test (see above). Cronbach's alpha for this task with the sample of 4,046 children who participated in the study was 0.721, and Bryant et al. (2015) showed strong correlations with the SATS 2 scores.

Variables Controlled For

All analyses included the sex of the child together with the mother's parity (i.e., the number of previous pregnancies resulting in a live- or still-birth) at the time of birth of the study child (0, 1+). In addition, the following analyses were undertaken.

Prenatal Chemical Exposures

The following variables were included since there is considerable evidence to implicate them in neurocognitive development: (i) maternal cigarette smoking mid-pregnancy (yes/no); (ii) maternal binge drinking mid-pregnancy (4 or more units of alcohol on at least 1 day in the past month) (yes/no); (iii) frequency of maternal consumption of oily fish in third trimester (none/any); (iv) duration of breast feeding (none or < 4 weeks/at least 4 weeks).

Parenting Strategies in Early Childhood

The factors included were: (i) frequency mother sings to the child at 24 months; (ii) the frequency that the mother reads to

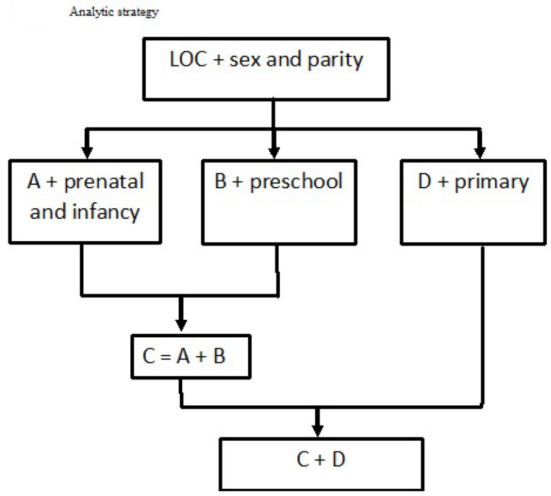

FIGURE 1 | Analytic strategy.

the child at 24 months; (iii) a parenting score derived from the frequency with which the mother attempts to teach and interact with the child at 24 months (<33/33+ score ranged from 18 to 40); (iv) frequency with which mother takes the child to a library at 30 months (rarely or never v. at least several times a year); (v) frequency mother takes child to places of interest at 30 months (never vs. at least several times a year); (vi) frequency is allowed objects to build with (once a week or less vs. more than once a week); (vii) exposed to people smoking when aged 3; (viii) has a diet of 'junk' food at age 3 (see Feinstein et al., 2008); (ix) mother's partner reads to the child at age 57 months (often/<often).

Variables Based on Fostering Educational Achievements

The following variables were included in this analysis: (i) no. of books owned by the child at age 6 (<20, 20–49, 50+); teacher report of the following: (ii) no. of children excluded from school in year 3 (0,1+); (iii) no. of children receiving free school meals in year 3 (0, 1–14, 15+); (iv) no. of disadvantaged pupils in the school (continuous); (v) frequency child does homework in year 3 (never vs. rest); (vi) teacher report of how supportive the study child's parents are (very supportive vs. rest).

Statistical Approach

The analyses are designed to determine the relationship between the children's mean scores on the mathematics and science tests and the mother's LOC orientation. The basic data use backward stepwise multiple regression adjusted for sex and parity since these are not open to modification once the child is conceived. For each analysis we noted the regression coefficient (b), the measure of variance explained (R^2) and the statistical significance (P). The analysis was then repeated but taking account of the prenatal chemical exposures (Model A). A separate analysis allowed for the parenting strategies (Model B), and a further analysis combined factors A and B (Analysis C). The fourth analysis allowed for factors indicating the fostering of the school-age child's ability (Analysis D). Subsequent analyses enabled all the factors in C and D to be taken into account together. Comparison of the regression coefficients and the amount of variance explained for each model was used to deduce the contribution of the different factors in explaining the ways in which the maternal LOC may have impacted on the child's scores. The analytic strategy is illustrated in **Figure 1**.

TABLE 1 | Proportion of children answering the different tests according to the locus of control orientation of their mothers in pregnancy.

Test	*N*	Mother external %	Mother internal %
Math Year 4	4623	43.2	56.8
Math Year 6	6926	44.3	55.7
Math Year 8	2453	41.9	58.1
M.A.	6842	38.0	62.0
Science	6951	44.6	55.4
All children	12471	45.2	54.8

M.A, mental arithmetic.

RESULTS

Response Rates by Maternal LOC

With the exception of the mental arithmetic score, which was only obtained by the study if the child was brought to the ALSPAC research clinic, the other tests of mathematics and science depended on the response rates of teachers rather than of the study families. As can be seen from **Table 1**, for the measures assessed in school, compared with all children, the proportions of responders whose mothers were external varied little, but there was a difference for the mental arithmetic with proportionately fewer children of external mothers.

The ways in which the basic social and environmental measures varied with the groups of children who completed the different measures is illustrated in **Supplementary Table 1**. In general there were few differences, although the group of children who completed the mental arithmetic test were less likely to have young mothers, mothers who smoked in mid-pregnancy or mothers with low levels of education.

The Measures

The basic details of each score are shown in **Supplementary Table 2**, and the correlations between the different scores are

TABLE 2 | Correlation matrix between the mental arithmetic, the three maths comprehension, the science, and total IQ scores (n = 438).

Test	M.A	Math Y4	Math Y6	Math Y8	Science	IQ
M.A	1.00					
Math Y4	0.477	1.000				
Math Y6	0.476	0.518	1.000			
Math Y8	0.397	0.487	0.590	1.000		
Science	0.388	0.401	0.480	0.415	1.000	
IQ	0.592	0.491	0.558	0.525	0.424	1.000

M.A., mental arithmetic; Y, school year.

TABLE 3 | Stepwise logistic regression results for sex of child, parity and maternal external locus of control for each of the mental arithmetic, the three maths comprehension, and the science scores.

Test	*N*	Ext LOC		Sex		R^2 %
		β [95%CI]	*P*	β [95%CI]	*P*	
Math Y4	4623	−1.21 [−1.39, −1.03]	3.8×10^{-40}	−0.25[−0.42, −0.07]	0.006	3.89
Math Y6	6665	−2.82 [−3.15, −2.49]	2.8×10^{-62}	−1.79[−2.12, −1.47]	7.0×10^{-27}	5.97[a]
Math Y8	2453	−2.76 [−3.32, −2.20]	7.6×10^{-22}	−1.44[−1.99, −0.88]	3.5×10^{-7}	4.68
M.A.	6787	−0.92 [−1.09, −0.76]	3.7×10^{-27}	−0.36[−0.52, −0.20]	1.4×10^{-5}	1.98
Science Y6	6689	−0.95 [−1.07, −0.83]	2.1×10^{-52}	DNE		3.72%[b]

M.A., mental arithmetic; DNE, did not enter model; Y, school year. [a]Model also includes parity −0.63 [−0.96, −0.31] P = 1.5 × 10^−4. [b]Model also includes parity −0.24 [−0.36, −0.12] P = 9.2 × 10^−5.

shown in **Table 2**. There are correlation coefficients ranging from 0.388 to 0.590 for the relationships between the test scores, and from 0.424 to 0.592 for their relationships with the total IQ score. Interestingly the maths scores tended to have relatively low correlations with the science reasoning score (range 0.388–0.480).

Initial Analyses by Maternal LOC

Allowing for sex of the child and maternal parity we show in **Table 3** that the children of mothers with an external LOC have strong negative relationships with the results of the tests, with results varying from differences of 0.92–2.82 SDs and *P*-values of 10^{-22} to 10^{-62}. These results took account of the child's sex which showed female reductions of between 0.25 and 1.79 SDs for the mathematics reasoning and arithmetic tests, with *P*-values from 0.006 to 10^{-27}, but no sex differences for the science reasoning test. Parity, as a proxy for the presence of older siblings, was only independently associated with maths and science reasoning in Year 6; both indicated that having an older sibling was associated with poorer achievement. It is clear from the results of all five tests that maternal external LOC has the largest associations (<−2 SDs) with mathematical reasoning in school years 6 and 8, although all the differences are highly statistically significant.

Explanation by Features of Pregnancy, Infancy, and the Preschool Period

We examined the extent to which factors relevant to pregnancy and infancy and known to be associated both with the mother's LOC and the child's cognitive development, might explain a proportion of the mechanism by which the mother's externality is associated with a reduction in maths and science abilities (Analyses A). Thus, in **Table 4** we show the change in effect size associated with a combination of maternal youth, failure to eat oily fish, prenatal smoking in mid-pregnancy, binge drinking mid-pregnancy and failure to breast feed at or beyond 4 weeks of age. The reduction of maths and science scores attributed to external LOC reduced by about a third, but mental arithmetic by slightly less (27%).

Independent of Analyses A we assessed the degrees to which the lower scores of children with external mothers were 'explained' by the parenting behaviors in the preschool period as defined by visits to library, visits to places of interest, mother sings to child, mother reads to child, parenting score, child allowed objects for building, exposed to environmental tobacco smoke, child's diet is poor (named 'junk food diet'). These factors (Analyses B) accounted for 38–58% of the reduced maths and science scores (**Table 5**).

TABLE 4 | Reductions in the effect size of maternal external locus of control after taking account of prenatal and infancy factors[a] as well as sex and parity, for each of the mental arithmetic, the three maths comprehension, and the science scores: results of stepwise regression.

Test	*N*	Adjusted β [95%CI]	Reduction[b] %	*P*	R^2 %
Math Y4	3987	−0.79 [−0.99, −0.60]	35	5.7×10^{-15}	6.81
Math Y6	5875	−1.80 [−2.16, −1.44]	38	8.0×10^{-23}	10.72
Math Y8	2252	−1.84 [−2.42, −1.25]	33	1.1×10^{-9}	7.69
M.A.	6188	−0.67 [−0.85, −0.49]	27	2.3×10^{-13}	3.73
Science Y6	5924	−0.64 [−0.77, −0.51]	34	4.1×10^{-21}	7.37

*[a]Adjusted for maternal age, consumption of oily fish in pregnancy, smoking cigarettes mid pregnancy, binge drinking mid-pregnancy, and breast feeding. [b]Reduction in the adjusted beta coefficient for external locus of control compared with results in **Table 3**.*

TABLE 5 | Reductions in the effect size of maternal external locus of control after taking account of preschool parenting factors[a] as well as sex and parity, for each of the mental arithmetic, the three maths comprehension, and the science scores: results of stepwise regression.

Test	*N*	Adjusted β [95%CI]	Reduction[b] %	*P*	R^2 %
Math Y4	3316	−0.75 [−0.96, −0.54]	38	6.9×10^{-12}	7.15
Math Y6	4864	−1.51 [−1.90, −1.11]	48	1.1×10^{-13}	10.14
Math Y8	1606	−1.17 [−1.87, −0.47]	58	0.001	10.31
M.A.	5050	−0.48 [−0.68, −0.28]	49	3.6×10^{-6}	4.63
Science Y6	4872	−0.55 [−0.70, −0.401	44	5.3×10^{-13}	7.04

*[a]Adjusted for visits to library, visits to places of interest, mother sings to child, mother reads to child, parenting score, child allowed objects for building, exposed to environmental tobacco smoke, child's diet is poor (named 'junk food diet'). [b]Reduction in the adjusted beta coefficient for external locus of control compared with results in **Table 3**.*

TABLE 6 | Reductions in the effect size of maternal external locus of control after taking account of prenatal, infancy and preschool factors[a] as well as sex and parity, for each of the mental arithmetic, the three maths comprehension, and the science scores: results of stepwise regression.

Test	*N*	Adjusted β [95%CI]	Reduction[b] %	*P* %	R^2 %
Math Y4	3069	−0.61 [−0.83, -0.38]	50	1.4×10^{-7}	7.53%
Math Y6	4459	−1.31 [−1.72, -0.89]	55	6.6×10^{-10}	11.48%
Math Y8	1603	−0.95 [−1.65, -0.26]	65	0.007	10.98%
M.A.	5343	−0.42 [−0.62, -0.23]	54	2.5×10^{-5}	5.07%
Science Y6	4026	−0.52 [−0.68, −0.351	47	6.0×10^{-10}	7.39%

[a]*Adjusted for maternal age, consumption of oily fish in pregnancy, smoking cigarettes mid pregnancy, binge drinking mid-pregnancy, breast feeding, visits to library, visits to places of interest, mother sings to child, mother reads to child, parenting score, child allowed objects for building, exposed to environmental tobacco smoke, child's diet is poor (named 'junk food diet').* [b]*Reduction in the adjusted beta coefficient for external locus of control compared with results in* ***Table 3****.*

TABLE 7 | Reductions in the effect size of maternal external locus of control after taking account of primary school age factors[a] as well as sex and parity, for each of the mental arithmetic, the maths comprehension, and the science scores: results of stepwise regression.

Test	*N*	Adjusted β [95%CI]	Reduction[b] %	*P* %	R^2 %
Math Y4	2553	−0.79 [−1.02, −0.56]	35	3.6×10^{-11}	13.73
Math Y6	2090	−1.54 [−2.12, −0.96]	47	1.8×10^{-7}	12.84
M.A.	2316	−0.64 [−0.93, −0.34]	31	2.6×10^{-5}	7.04
Science Y6	2221	−0.54 [−0.75, −0.331	45	5.0×10^{-7}	9.24

[a]*Adjusted for number of books owned by the child, whether children had been excluded from the child's class, no. of children in the class receiving free school meals, teacher reports that the parents are very supportive toward the child's learning, and the frequency with which the child does school homework.* [b]*Reduction in the adjusted beta coefficient for external locus of control compared with results in* ***Table 3****.*

TABLE 8 | Reductions in the effect size of maternal external locus of control after taking account of prenatal, infancy, preschool and primary age factors[a] as well as sex and parity, for each of the mental arithmetic, the maths comprehension, and the science scores.

Test	*N*	Adjusted β [95%CI]	Reduction[b] %	*P*	R^2 %
Math Y4	1806	−0.63 [−0.90, −0.35]	48	1.0×10^{-5}	14.46
Math Y6	1953	−1.25 [−1.86, −0.64]	57	5.7×10^{-5}	13.75
M.A.	2121	−0.48 [−0.79, −0.17]	49	0.003	7.71
Science Y6	1946	−0.49 [−0.71, −0.261	50	2.6×10^{-5}	10.41

[a]*See text for list of factors offered to the analysis.* [b]*Reduction in the adjusted beta coefficient for external locus of control compared with results in* ***Table 3****.*

Offering all features of Analyses A and B to the regression (Analyses C; **Table 6**) indicated that they explained between 47 and 65% of the reduction in scores of the children of externally oriented mothers. The size of the reduction was greatest for mathematical reasoning in School Year 8, and least for scientific reasoning.

Explanation by School-Age Factors

For Analyses D we took account independently of the following variables: number of books owned by the child, whether children had been excluded from the child's class, no. of children in the class receiving free school meals, teacher reports that the parents are very supportive toward the child's learning, and the frequency with which the child does school homework. Unfortunately, the data provided by schools resulted in a reduction in numbers such that only 618 children could be considered in analyzing Mathematics in Year 8. Consequently, those relationships were omitted from **Table 7**. For all the remaining tests, these school-age learning related variables were responsible for between 31 and 47% of the poor achievements of the children of the external mothers.

Overall Explanation

The results of the full analyses are shown in **Table 8**. This illustrates the fact that the mothers' external LOC remains significantly associated with poor achievement in these tests, but that around half of the difference in the scores achieved by children of parents who were internally oriented is related to behaviors and choices made by the parents in regard to lifestyle, parenting, and schooling.

DISCUSSION

Overview of Results

We hypothesized and found that children whose mothers were more external : (a) have poorer educational achievements; and (b) that the relationships between the maternal LOC and the child's mathematical and science abilities would be mediated through maternal lifestyle, parenting behaviors and attitudes to education. Children of mothers who are externally oriented scored significantly lower on tests of mathematics and scientific understanding than children of mothers who are internally controlled. At least half of the variance was associated with mothers' parenting behaviors and lifestyles.

Placing the Results in Context

The present study concentrated on assessments of mathematical and science reasoning which were designed specifically for the ALSPAC study and administered in schools. We used these data rather than data from national tests, because they assessed mathematical and scientific reasoning. Past research has shown that these maths tests (as assessed in school year 4), together with the child's ability in mental arithmetic, make independent contributions to children's achievement in mathematics in the national tests (Nunes et al., 2012). Additionally, the science reasoning test has been shown to be strongly predictive of the results from subsequent national science tests (Bryant et al., 2015).

This is not the first study using the ALSPAC cohort to have shown a cognitive association with maternal LOC. Previously, Golding et al. (2017a) found maternal external LOC to be associated with decreased ability in offspring IQ, as measured

using the WISC, with children of externally oriented mothers having a disadvantage of approximately 7 IQ points at age 8. In that study we also investigated possible mechanistic explanations for the results by determining the extent to which three separate sets of factors known to be associated with the LOC orientation might explain the findings. We found (a) perinatal life-style exposures, (b) parenting attitudes and strategies and (c) socio-economic circumstances, largely explained the mechanism through which the externality of the mother may be associated with influencing the cognition of the child. In fact, perinatal life-style exposures and parenting attitudes and strategies explained about 50% of the difference found between the abilities of children of internal and external mothers.

Limitations of the Study

We list our study limitations below.

(1) We did not allow for concurrent social circumstances as we wished to concentrate on factors that could be changed for mothers to become less external and more internal.
(2) The mental arithmetic scores used were confined to the children who attended the clinic held at the ALSPAC offices when the children were aged 8. As with all such attendances, there was a bias in that children whose mothers were externally oriented were less likely to attend. This bias must be borne in mind when interpreting the results.
(3) It is possible that there are other confounders that should have been taken into account, and which would have reduced the associations.
(4) To our knowledge there are no similar longitudinal datasets which could be used to determine whether these results can be repeated. Such repetition would currently provide additional support for our hypotheses.

Strengths of the Study

(1) In comparison with studies on this topic, this sample size is numerically large.
(2) Although almost all longitudinal studies find attrition in attendance for measurements as their study population ages, in contrast, for the ALSPAC tests of maths and science reasoning, all children in a school class were included, and consequently bias related to the LOC of the study mother was reduced.
(3) The mothers' LOC was measured in the first 6 months of pregnancy (90% by 28 weeks gestation), and can be considered a baseline, largely unaffected by the outcome of the pregnancy. The consistency of the LOC personality characteristic over time is shown by the correlations of the pregnancy measure with repeated measures of her LOC ($r = 0.55$ and 0.54) using the same questions obtained after 6 and 18 years respectively (Nowicki et al., 2018).

Is the Relationship Causal?

We demonstrated significant associations between mothers' LOC and their children's mathematics and science reasoning tasks, but a key question concerns whether the findings imply causality. One set of results is consistent with such an assumption; factors we have shown elsewhere to explain about half of the original association with both maternal LOC and subsequent parenting behavior.

There are two ways in which the relationship between maternal LOC and the child's scholastic abilities could be more convincingly shown to be causal – the first concerns the repetition of the findings in other communities, but more convincing would be the undertaking of randomized controlled trials comparing groups who had been encouraged to become more internal with those where no such intervention had occurred. Opportunities for such interventions could be based in secondary schools and/or provided to women attending antenatal classes.

CONCLUSION

In this paper we have used tests of mathematical and scientific understanding since they illustrate fundamental abilities which will provide the basis for educational achievement in technical spheres in the future. We have concentrated the analysis on features of the mother that could be altered (in theory at least). It is also true that because LOC orientation is learned, it can be changed at any stage of life through learning. In the present study, we showed that children of an externally oriented mother are more likely to score poorly on tests concerning the understanding of fundamental mathematical and scientific concepts compared to children of an internally controlled mother, and, importantly, we found that about half of this is due to features of the behavior of the mothers. Programs to enable mothers to become more internally oriented may also help them use behaviors resulting in long-term benefit to the child's educational achievements, but further research is needed to ensure that the relationship we have shown between parental LOC and child achievement results is causal.

AUTHOR CONTRIBUTIONS

JG and SN raised the funding; had the idea and wrote the first draft. TN and PB advised on the interpretation of the measures. SG and GE analyzed the data. YI-C contributed to the initial manuscript. All authors were subsequently involved in re-writing and editing.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00194/full#supplementary-material

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Locus of Control, Self-Control, and Gender as Predictors of Internalizing and Externalizing Problems in Children and Adolescents in Northern Chile

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Background: Both the control that people attribute to themselves over a situation (locus of control) and the control they attribute to themselves (self-control) have been proposed as aspects that can have an effect on internalizing problems in young people. There is little evidence of this relationship in the infantile-juvenile population in Latin America.

Objective: To establish whether there is a significant predictive relationship of locus of control and self-control over internalizing and externalizing problems in the infantile-juvenile population, both at a general level and dimension-specific. These include depression, anxiety, social anxiety, somatic complaints, and post-traumatic stress.

Methods: A cross-sectional-correlational study was carried out to establish if there was a possible predictive relationship in 3,664 schoolchildren of both primary (4th–6th grade) and secondary (7th–12th grade) in northern Chile, using the short version of the Nowicki-Strickland scale to measure locus of control, the Tangney scale to measure self-control, and the Child and Adolescent Evaluation System (SENA) to measure the dimensions of internalized problems.

Hypotheses: (1) Greater self-control is associated with lower levels of internalizing and externalizing problems. (2) Higher external locus of control is associated with higher levels of internalizing and externalizing problems. (3) Self-control, locus of control, and gender can together significantly predict each of the internalizing and externalizing problems.

Results: Evidence is found to support the first two hypotheses fully and partially support the third, since gender did not function as a predictor in all models.

Conclusion: The results confirm previous international research in that both locus of control and self-control appear to have a significant influence on internalizing and externalizing problems. Implications for mental health promotion in this population are discussed.

Keywords: locus of control, self-control, internalizing and externalizing problems, infantile-juvenile, mental health

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INTRODUCTION

Globally, it is estimated that 1 in 5 children and adolescents have mental health problems (World Health Organization, 2003, (2012)), affecting their current and future quality of life, academic achievement and social relations. Mental health is an especially relevant issue in Chile, and little research has been undertaken on the child and youth populations. In international comparisons, evidence has been found that children under 6 years of age have low mental health indicators (Rescorla et al., 2011, 2012). The last study that widely included this population was that of Vicente et al. (2012), which found more symptoms in children than in adolescents.

The classic categorization of mental health problems has been to consider them as either internalizing or externalizing (Achenbach and Edelbrock, 1981). Internalized mental health problems have been studied both together (White et al., 2013), but more often, they have been analyzed separately. These usually include depression, anxiety, social anxiety, somatization, post-traumatic stress, and obsessive-compulsive disorder (Balan et al., 2017; Boyraz et al., 2019). Externalized mental health problems include disruptive or inappropriate behaviors, such as Attention Deficit, Hyperactivity-Impulsivity, Anger Control Problems, Aggression, Defiant Behavior, and Antisocial Behavior (Jenson et al., 2011; Lewis et al., 2016; Van Heel et al., 2019; Bishop et al., 2020). The first two are sometimes considered to be specifically executive function problems (Re et al., 2015).

Analyzing psychosocial variables related to internalizing and externalizing problems would facilitate progress in their prevention and promotion of mental health. Ollendick and Grills (2016), in a review, suggest that locus of control and self-control should be measured simultaneously to better understand childhood anxiety. Depression has been found to be associated with locus of control and self-control in children (Garaigordobil et al., 2017), and both have presented a significant association with each other (Autry and Langenbach, 1985; Gwandure and Mayekiso, 2010).

Based on Social Learning Theory, Rotter (1954) developed the concept of locus of control of reinforcement, the way in which an expectation can be strengthened is central: "The effects of reward or reinforcement on preceding behavior depends in part on whether the person perceives the reward as contingent on his own behavior or independent of it" (Rotter, 1966, p. 1). External locus of control is when these effects are "typically perceived as the result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him" (Rotter, 1966, p. 1). Conversely, a person is considered to have an internal locus of control, when they perceive that there is a cause-and-effect relationship based on their own behavior (Rotter, 1966).

The control that children and adolescents perceive over what happens to them can influence their emotional problems (Levin, 1992). Locus of control is affected by context, as reflected in a study of institutionalized children, who tended to have a higher external locus of control compared to those living with their families (Król et al., 2019). There is also the possibility that internalizing problems can be influenced by socio-economic factors including area of residence (McDermott et al., 2017).

Locus of Control has been found to be linked to mental health (Groth et al., 2019; Kesavayuth et al., 2019) and may predict suicide risk (Loftis et al., 2019) and discipline problems (Tony, 2003). Adolescents with a high external locus of control score tended to have more emotional problems when under high levels of stress (Huebner et al., 2001; Aspelmeier et al., 2012). Both their direct relationship to depression and anxiety and their possible mediating effects have been reported (Di Pentima et al., 2019). The effect of social stress on locus of control has also been considered (Millman et al., 2017). A longitudinal study found an association between an increased external locus of control and depression (Sullivan et al., 2017). Also, locus of control was found to be a significant predictor of externalizing problems in adolescents (Liu et al., 2000). When children perceive that they have little control over events, they are more likely to develop externalizing problems (Jackson et al., 2000).

"Self-control is the exertion of control over the self by the self. That is, self-control occurs when a person (or other organism) attempts to change the way he or she would otherwise think, feel, or behave" (Muraven and Baumeister, 2000, p. 247). Nigg (2017) proposes that self-control is an essential aspect of the voluntary process of self-regulation, being also key to the understanding of psychological problems. Self-control has also been proposed as a sub-domain of social skills (Gresham and Elliot, 1990). Students who have high self-control would get better grades, have higher self-esteem, as well as better interpersonal relationships, fewer psychological and emotional problems (Tangney et al., 2004). A negative relationship has been found between self-control and internalizing problems (Nie et al., 2014), particularly with depression (Jun and Choi, 2013) and anxiety (Sánchez-Aguilar et al., 2019). The possible mediating role of self-control between perceived stress and life satisfaction has also been considered (Zheng et al., 2019). It has also been proposed that self-control is important in relation to externalizing problems (Franken et al., 2015; Wills et al., 2016). In comparisons of adolescents and adults it has been shown that the former have less self-control (Oliva et al., 2019). Self-control is acquired from early childhood, is adaptive, and considered a protective factor against the onset of different psychopathologies and should be taken into consideration when developing public policies (Moffitt et al., 2011).

Gender differences have been found in the distribution of mental health problems in this population. It is more common for females to have internalizing problems (Chaplin and Aldao, 2013; Schäfer et al., 2017), conversely, males present with more externalizing problems (Navarro-Pardo et al., 2012; Campos et al., 2014).

The purpose of this study was to establish the relationship between locus of control, self-control, and internalizing problems in school children from the fourth year of primary school to the last grade of secondary education in northern Chile.

Most of the research in the areas mentioned above, focused on populations over 12 years of age, so considering

a broader age range would be beneficial to the topic. In this research, the age range is 8–18 years old. There are no other studies in Chile that consider all these variables in the child and adolescent population, and can thence be used to inform mental health programs and public policies, and thus, contribute to improvements in the quality of life for young people.

We had three hypotheses:

(1) Greater self-control is associated with lower levels of internalizing and externalizing problems.
(2) Higher external locus of control is associated with higher levels of both internalizing and externalizing problems.
(3) Self-control, locus of control and gender can together significantly predict each of the internalizing and externalizing problems under consideration.

MATERIALS AND METHODS

Methodology

Our study design was transactional-correlational as all variables were measured at a single time point (Hernández et al., 2010) and comprised approximately 10% of the school enrolment for the entire region.

Participants

The total sample comprised 3,664 students, in two different age groups and used two different versions of the SENA (Child and Adolescent Evaluation System) instrument adapted to be age appropriate. Both groups included public, government-subsidized and private schools.

The primary school group comprised 1,387 students between the fourth and sixth year of primary education from different schools in Arica. Boys comprised 46% and girls 53.6%, and ranged in age from 8 to 11 years old (mean 10 years; standard deviation was 0.83 years). Just over half (52.1%) declared themselves to be Latin American, 26% Aymara, 6.4% Mapuche and the remainder as belonging to other ethnic groups.

The secondary school group included 2,277 students between the seventh and last year of primary education (49.6% male, 50.4% female). The age range was 12–18 years (mean 14.4; standard deviation was 1.8 years). Again just over half (56.1%) identified as Latin American, 25.7% Aymara, 4.4% Mapuche and the rest as belonging to other ethnic groups. **Table 1** shows sociodemographic characteristics of participants at baseline.

The automated electronic correction of the instruments used allowed for up to 10% of unanswered questions, so those cases that exceeded that percentage were immediately discarded from further analyses. The imputation of missing values was used, which did not exceed 1% of the answers to each item. Missing values were imputed by the mean. Cases with an inconsistency score $\geq$ 1.6 were disgarded as recommended by the SENA authors, As a result, a total of 120 cases were omitted from the final sample.

Instruments

Child and Adolescent Evaluation System (SENA) (Fernández-Pinto et al., 2015)

This instrument was developed to detect a wide range of emotional and behavioral problems in the 3–18 age range. It was constructed and validated entirely in Spanish. Only internalizing and externalizing problem scales were considered in this research:

Internalizing problems: Depression, Anxiety, Social anxiety, Somatic complaints, Post-traumatic symptomatology, and Obsession-compulsion.

Externalizing problems: Attention problems, Hyperactivity-impulsivity, Anger control problems, Aggression, Defiant behavior, and Antisocial Behavior.

It is a 5-point Likert scale graded from "never or almost never" to "always or almost always." The total of each dimension is the average of the answers that constitute it, which can vary between 1 and 5 in a continuous way. It has an Inconsistency control scale.

The primary school version (8–12 years) had 10 scales to measure mental health: 48 items measuring internalizing problems and 39 items measuring externalizing problems. The secondary school version had 12 scales to measure mental health: 58 items measure internalizing problems and 46 measure externalizing problems. Each of the dimensions varied between 3 and 14 items, with an average of 8 per scale. Some examples of the questions are: "I feel that no one cares what I do" (Depression); "I get anxious or overwhelmed by my problems" (Anxiety); "I get nervous when there are many people around" (Social Anxiety); "I get unpleasant images of things that have happened to me." (Post-traumatic stress). A higher score indicated greater problems for each scale.

TABLE 1 | Sociodemographic characteristics of participants at baseline.

	n	%
Gender		
Female	1891	51,6
Male	1773	48,4
Grade		
4	536	38,6
5	468	33,7
6	383	27,6
7	471	20,7
8	460	20,2
9	407	17,9
10	358	15,7
11	324	14,2
12	257	11,3
Ethnicity		
Aymara	945	25,8
Quechua,	38	1,0
Mapuche	189	5,2
Afro-descendant	109	3,0
Latin American	1999	54,6
Other	384	10,5

The present investigation used the self-report versions of primary 8–12 years and secondary 12–18 years. Recently, Sánchez-Sánchez et al. (2016) found that the reliability of their subscales is above 0.7 in Spain. In the present investigation, all scales had reliability above 0.7. SENA also includes demographic questions on age, gender and school grade.

The Short Version of the Child Internal–External Locus of Control Scale (CNSIE) (Nowicki and Strickland, 1973)

Developed from the full 40-item version, specifically for children and adolescents. It has one dimension of external locus of control with a YES/NO response type for each question. There are different versions of this instrument, but in the present study the 12-item version was used. Some items are reversed scored. A higher score indicates a higher external locus of control. Criteria validity and reliability test-retest have been found to be adequate (Nowicki, 1976; Nowicki and Duke, 1983; Nowicki et al., 2018). The Guttman Split-half coefficient in the present investigation was 0.55. A back-translation procedure was used to ensure compatibility.

Brief Scale of Self-Control (BSCS) (Tangney et al., 2004)

This is a 13-item Likert response scale, where 1 is "don't like it at all," and 5 is "like it a lot." It was developed from the full 36-item scale. A higher score indicates greater self-control. Its reliability is 0.85, and it is one-dimensional. An example of an item is "I refuse things that are bad for me." The BSCS has been used in more than 50 studies and has good evidence of reliability and validity (Lindner et al., 2015). Some items are reverse scored for analysis. A higher score indicates greater self-control. The reliability in the present investigation was 0.68. The Spanish version was provided by the author of the scale.

Procedure

(1) Approval of the Ethics Committee of the University of Tarapacá. This study formed part of a larger project of the Educational Justice Center.
(2) Forty-two educational establishments in the city of Arica were invited to participate in the study. A total of 69% (29) of schools agreed to participate.
(3) Informed parental and student consent was obtained.
(4) Assessment was carried out within the school classes. At least two trained interviewers were present to answer questions together with the class teachers. The questionnaires were given in the order: CNSIE, BSCS and finally SENA. Administration was approximately 45 min.

Data Analysis

The demographic descriptions of each sample were presented, and then the basic statistics of the dimensions of the SENA. Correlations between locus of control, self-control, internalizing and externalizing problems in each sub-dimension of the SENA were then presented for each group. Examination of results showed little deviation from the norm. Given that the variables did not seem to be significantly skewed or have issues with kurtosis, Pearson correlations were used as the variables could take continuous values between 1 and 5. Multiple linear regressions for gender and both psychosocial variables on each of the internalizing and externalizing problems was then displayed. SPSS version 22 program was used. A stepwise regression was undertaken.

RESULTS

Primary School Sample

The values of means, standard deviations, asymmetry, kurtosis, and the possible range of the dimensions of internalizing and externalizing problems of the SENA, locus of control, and self-control in the primary school sample are shown in **Table 2**. It can be seen that asymmetry and kurtosis for almost all are in acceptable ranges of ±2 indicating that the variables are normally distributed (George and Mallery, 2010). All were in the range proposed by Ryu (2011) for acceptable normal distributions.

The correlations between locus of control, self-control, internalizing and externalizing problems are presented in **Table 3**. It can be seen that locus of control and self-control correlate significantly and negatively to each other, in that the higher the external locus of control, the lower the self-control. The correlation of locus of control with each of the internalizing and externalizing problems is positive, in that the greater the external locus of control, the greater the internalizing and externalizing problems. Self-control correlates negatively with each of the internalizing and externalizing problems, in that the greater the self-control, the fewer the internalizing and externalizing problems. Locus of control was most strongly associated with depression, and self-control had the highest correlation with attention problems. Social anxiety showed the lowest correlation with both.

Secondary School Sample

The values of means, standard deviations, asymmetry, kurtosis, and the possible range of the dimensions of internalizing and externalizing problems of the SENA, locus of control, self-control, and global indexes of secondary SENA are shown in **Table 4**. It can be seen that almost all asymmetry and kurtosis were also within acceptable ranges of normal distribution (±2) (George and Mallery, 2010; Ryu, 2011). The only exception was antisocial behavior with a kurtosis that was too high. This variable was therefore omitted from further analyses.

The correlations between locus of control, self-control, internalizing, and externalizing problems of the secondary school students are presented in **Table 5**. It can be seen that locus of control and self-control also correlate significantly and negatively in this sample.

The correlation of locus of control with each of the internalizing and externalizing problems again is positive, so the higher the external locus of control, the higher the internalizing or externalizing problems. In turn, self-control again correlates negatively with each of the internalizing and

TABLE 2 | Descriptive statistics internalized and externalized problems SENA primary.

	Minimum	Maximum	*M*	*DS*	Asymmetry	Kurtosis
Depression	1,00	5,00	1,96	0,76	1,191	1,255
Anxiety	1,00	5,00	2,23	0,75	0,666	0,251
Social anxiety	1,00	5,00	2,45	0,83	0,416	−0,269
Somatic complaints	1,00	5,00	2,18	0,74	0,645	0,118
Post-traumatic stress	1,00	5,00	2,22	0,77	0,656	0,024
Attention problems	1,00	5,00	2,26	0,75	0,662	0,363
Hyperactivity-impulsivity	1,00	5,00	1,92	0,69	1,095	1,350
Anger problems	1,00	5,00	1,92	0,85	1,191	0,944
Aggressiveness	1,00	5,00	1,30	0,48	2,372	6,536
Defiant behavior	1,00	5,00	1,45	0,66	2,192	5,841
Locus of control	12,00	22,00	16,91	1,92	0,093	−0,451
Self-control	16,00	52,00	36,69	5,83	−0,257	−0,147

TABLE 3 | Correlations between locus of control, self-control, internalized and externalized problems in primary.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
(1) Locus of control	–											
(2) Self-control	−0,373**	–										
(3) Depression	0,304**	−0,337**	–									
(4) Anxiety	0,192**	−0,231**	0,671**	–								
(5) Social anxiety	0,161**	−0,170**	0,468**	0,535**	–							
(6) Somatic complaints	0,271**	−0,281**	0,649**	0,610**	0,413**	–						
(7) Post-traumatic stress	0,276**	−0,272**	0,680**	0,706**	0,523**	0,634**	–					
(8) Attention problems	0,277**	−0,438**	0,597**	0,543**	0,392**	0,519**	0,524**	–				
(9) Hyperactivity-impulsivity	0,210**	−0,367**	0,490**	0,504**	0,314**	0,457**	0,464**	0,738**	–			
(10) Anger problems	0,208**	−0,330**	0,555**	0,547**	0,368**	0,481**	0,509**	0,574**	0,627**	–		
(11) Aggressiveness	0,169**	−0,285**	0,363**	0,326**	0,179**	0,331**	0,318**	0,439**	0,567**	0,581**	–	
(12) Defiant behavior	0,205**	−0,343**	0,433**	0,357**	0,198**	0,354**	0,338**	0,494**	0,564**	0,544**	0,636**	–

$^{**}p < 0.01$.

TABLE 4 | Descriptive statistics internalized and externalized problems SENA secondary.

	Minimum	Maximum	*M*	*DS*	Asymmetry	Kurtosis
Depression	1	5	2,14	0,85	0,927	0,257
Anxiety	1	5	2,54	0,87	0,588	−0,313
Social anxiety	1	5	2,42	0,82	0,592	−0,030
Somatic complaints	1	5	2,30	0,79	0,728	0,171
Post-traumatic stress	1	5	2,10	0,71	0,819	0,302
Obsessive-compulsive	1	5	2,14	0,74	0,709	0,213
Attention problems	1	5	2,37	0,79	0,610	0,057
Hyperactivity-impulsivity	1	5	2,05	0,68	0,901	0,867
Anger problems	1	5	2,10	0,88	1,010	0,583
Aggressiveness	1	5	1,39	0,50	2,002	5,206
Defiant behavior	1	5	1,60	0,73	1,594	2,610
Antisocial behavior	1	5	1,23	0,36	2,798	10,748
Locus of control	12	24	16,1	2	−0,398	−0,202
Self-control	13	52	35,9	6	−0,18	−0,281

externalizing problems, so the greater the self-control, the fewer the internalizing problems.

The variable that had the strongest relationship to locus of control was, again, depression. Attention problems also had the highest correlation with self-control, and aggressiveness had the lowest correlation with locus of control and self-control; and the obsessive-compulsive scale had the lowest correlation with self-control.

TABLE 5 | Correlations between locus of control, self-control internalized and externalized problems in secondary.

	1	2	3	4	5	6	7	8	9	10	11	12	13
(1) Locus of control	–												
(2) Self-control	−0,383**	–											
(3) Depression	0,319**	−0,394**	–										
(4) Anxiety	0,189**	−0,313**	0,763**	–									
(5) Social anxiety	0,203**	−0,223**	0,475**	0,553**	–								
(6) Somatic complaints	0,231**	−0,338**	0,708**	0,670**	0,404**	–							
(7) Post-traumatic stress	0,273**	−0,303**	0,737**	0,736**	0,491**	0,634**	–						
(8) Obsessive-compulsive	0,144**	−0,198**	0,523**	0,651**	0,474**	0,488**	0,603**	–					
(9) Attention problems	0,302**	−0,548**	0,510**	0,498**	0,322**	0,504**	0,491**	0,412**	–				
(10) Hyperactivity-impulsivity	0,196**	−0,424**	0,431**	0,463**	0,233**	0,427**	0,464**	0,446**	0,703**	–			
(11) Anger problems	0,212**	−0,392**	0,508**	0,499**	0,223**	0,439**	0,481**	0,391**	0,483**	0,532**	–		
(12) Aggressiveness	0,132**	−0,320**	0,282**	0,232**	0,082**	0,243**	0,280**	0,278**	0,362**	0,476**	0,514**	–	
(13) Defiant behavior	0,190**	−0,374**	0,422**	0,333**	0,127**	0,349**	0,350**	0,271**	0,431**	0,468**	0,512**	0,522**	–

**$p < 0.01$.

Prediction of each of the internalizing and externalizing problems using gender, locus of control and self-control is presented in **Table 6** for both age groups. It can be seen that, in each regression model, both locus of control and self-control were significant predictors. Only for the aggressiveness dimension did locus of control not function as a significant predictor in the secondary school group, however, locus of control did predict aggressiveness in the primary school group.

Gender was not a significant predictor in either model. For the primary school sample, gender did not contribute to the model for the prediction of somatic complaints. For depression, the prediction with gender only reached the $p < 0.05$ level. While among the externalizing problems, gender did not predict attention problems nor anger control problems.

In the secondary school sample, gender did not predict attention problems. Likewise, gender goes from third to second place among the predictors in regression models for depression, anxiety, post-traumatic stress, hyperactivity-impulsivity and defiant behavior.

In both samples, for those dependent variables that gender did predict, being female predicted greater internalizing problems, while being male predicts greater externalizing problems. The only exception was anger control problems where being female predicted a higher level.

In the primary school sample, between 5 and 15% of the individual internalizing problems could be predicted by the locus of control, self-control, and gender variables. Social anxiety was least predicted of all independent variables. Depression was the most likely of the internalizing problems to be predicted. Within the same group, 12–21% of the externalizing problems could be predicted by the models. Anger control problems is the least predictable variable, whilst attention problems are most commonly predicted.

In the secondary school sample, locus of control, self-control, and gender predicted 5–22% of the internalizing problems separately, with obsessive-compulsion being the one that could be predicted the least and depression the most, whilst among the externalizing problems the models predicted 12–31%. Aggressiveness problems was the least predictable of all independent variables but attention problems was predicted the most.

DISCUSSION

The objective of this study was to establish the relationship between locus of control, self-control, internalized and externalized problems in school children from the fourth year of primary education to the last grade of secondary education in northern Chile.

The study results supported our first two hypotheses, showing a significant relationship between both locus of control and self-control and the internalizing and externalizing problems in the expected directions.

Partial evidence was found for hypothesis three that self-control, locus of control, and gender could together significantly predict each of the internalizing and externalizing problems. However, gender did not contribute significantly to the prediction of all of the internalizing and externalizing problems. There were also some variation between the primary school and the secondary school sample groups. In both groups, the regression models better predicted externalizing rather than internalizing problems. In addition, in the secondary sample the models predicted more than in the primary.

Self-control and locus of control were significant predictors in all regression models of internalizing and externalizing problems in both age groups. There was one exception: in the secondary school sample, locus of control did not add anything to the prediction of aggressiveness, although in primary school it was a significant predictor.

The significant negative relationship between self-control and internalizing problems was consistent with previous research, in that higher levels of self-control are negatively associated with symptoms of depression in both primary and secondary schools (Weisz et al., 2004; Jun and Choi, 2013;

TABLE 6 | Regression models for each internalized and externalized problems in primary and secondary.

Primary					Secondary				
Source[a]	**Predictor**	**R^2 model[b]**	**β[c]**	***p***	**Source[a]**	**Predictor**	**R^2 model[b]**	**β[c]**	***p***
Internalized problems									
Depression		0.153			Depression		0.224		
	Self-control		−0.264	0.000		Self-control		−0.321	0.000
	Locus of control		0.208	0.000		Gender		−0.192	0.000
	Gender		−0.050	0.044		Locus of control		0.194	0.000
Anxiety		0.071			Anxiety		0.155		
	Self-control		−0.191	0.000		Self-control		−0.285	0.000
	Locus of control		0.124	0.000		Gender		−0.230	0.000
	Gender		−0.064	0.014		Locus of control		0.077	0.000
Social anxiety		0.051			Social anxiety		0.090		
	Self-control		−0.138	0.000		Self-control		−0.172	0.000
	Gender		−0.115	0.000		Gender		−0.160	0.000
	Locus of control		0.114	0.000		Locus of control		0.136	0.000
Somatic complaints		0.111			Somatic complaints		0.175		
	Self-control		−0.208	0.000		Self-control		−0.295	0.000
	Locus of control		0.194	0.000		Gender		−0.223	0.000
						Locus of control		0.116	0.000
Post-traumatic stress		0.113			Post-traumatic stress		0.148		
	Locus of control		0.203	0.000		Self-control		−0.235	0.000
	Self-control		−0.203	0.000		Gender		−0.168	0.000
	Gender		−0.077	0.003		Locus of control		0.182	0.000
					Obsessive-compulsive		0.046		
						Self-control		−0.168	0.000
						Locus of control		−0.080	0.008
						Gender		−0.054	0.000
Externalized problems									
Attention problems		0.206			Attention problems		0.309		
	Self-control		−0.389	0.000		Self-control		−0.506	0.000
	Locus of control		0.132	0.000		Locus of control		0.108	0.000
Hyperactivity-impulsivity		0.158			Hyperactivity-impulsivity		0.182		
	Self-control		−0.324	0.000		Self-control		−0.408	0.000
	Gender		0.137	0.000		Gender		0.045	0.019
	Locus of control		0.082	0.002		Locus of control		0.040	0.049
Anger control problems		0.116			Anger control problems		0.165		
	Self-control		−0.294	0.000		Self-control		−0.366	0.000
	Locus of control		0.099	0.000		Gender		−0.090	0.000
						Locus of control		0.071	0.001
Aggressiveness		0.121			Aggressiveness		0.123		
	Self-control		−0.240	0.000		Self-control		−0.318	0.000
	Gender		0.192	0.000		Gender		0.148	0.009
	Locus of control		0.071	0.009					
Defiant behavior		0.127			Defiant behavior		0.142		
	Self-control		−0.304	0.000		Self-control		−0.353	0.000
	Locus of control		0.088	0.001		Locus of control		0.055	0.009
	Gender		0.067	0.008					

[a]Internalized and externalized problem to be predicted in each model. [b]R^2 adjusted from the model. [c]β standardized Beta coefficient (β represents the change in the standard deviation of the dependent score resulting from the change of one standard deviation of the independent variable).

Nie et al., 2014). Furthermore, the findings for locus of control were also consistent with previous research linking it to internalizing problems such as depression (Culpin et al., 2015; Di Pentima et al., 2019) and anxiety (Król et al., 2019). Thus, both anxiety and depression were significantly associated with locus of control, as both would essentially imply the perception that

the individual has no control over his or her life circumstances (Di Pentima et al., 2019).

The present study confirms the importance of considering locus of control and self-control simultaneously in regard to internalizing problems (especially anxiety) as suggested by Ollendick and Grills (2016). Both the association between self-control and externalizing problems (Franken et al., 2015), and between locus of control and externalizing problems are consistent with previous research (Liu et al., 2000).

These results provide evidence for the prediction models proposed in this study in which self-control, locus of control, and gender together, seem to function as predictors of internalizing and externalizing problems in school aged children. The indication of a predictive role was higher for the secondary school group, and it might be explained by the higher demands in school for this age group (Broeren and Muris, 2009; Nie et al., 2014). In Chile, the transition from eighth to ninth grade is an important milestone, as it is in the latter, that final average grades begin to count as part of the score for future university selection. This can generate greater stress than in the early school years, given the greater performance pressure, among other things, reflected in an increase of students that have to retake a year (Ministerio de Educación de Chile, Centro de Estudios, Unidad de Estadísticas, 2018).

Future research should consider other variables that could add more predictive power to these models. For example, psychosocial variables, such as social support and resilience, should be investigated as they can be incorporated into intervention programs (Carle and Chassin, 2004; Attar-Schwartz et al., 2019).

The fact that depression had the highest association with both locus of control and self-control in both age groups, implied that depression is mostly influenced by the ability for, and experience of, control between internalizing problems. Furthermore, although anxiety is usually studied as often as depression, the results of the present study showed that in primary school, both post-traumatic stress and somatic complaints were influenced more by self-control. In secondary school, although anxiety increases, it is still slightly below the last two. Social anxiety increases almost twice as much, although it did not reach the level of general anxiety. These results suggest that it will be necessary to analyze them as separate variables, as well as to assess them together, but as independent sub-dimensions. Studying depression and anxiety from a single score may hide the fact that depression could be more influenced by locus of control and self-control variables.

Between the externalizing problems, it was noteworthy that attention problems were explained mostly by independent variables followed by hyperactivity-impulsivity, although it is evident that the externalizing problems had a stronger relationship to the control variables compared to the internalizing. This is consistent with the importance given to the role of locus of control and self-control in the literature about externalizing problems (Jenson et al., 2011).

It is remarkable that self-control weighs more than locus of control in the prediction of each of the internalizing and externalizing problems. This may be because children and adolescents' ability to control impulses, emotions, thoughts and behaviors may be more directly related to their mental health than their assessment of whether or not their own behaviors might affect their outcomes. However, the latter can provide information on self-management.

It has been proposed that the hormonal changes at puberty may cause girls to experience greater internalizing problems, without ignoring gender identity and other relevant psychosocial aspects (Sanborn and Hayward, 2003; Natsuaki et al., 2015). All these aspects could help explain the differences between primary and secondary samples concerning gender.

Although the data provided by this research are significant, they have certain limitations, such as its cross-sectional nature, the lack of random selection, and the restrictions inherent in the use of self-report inventories as the primary data source. Since this is a cross-sectional study, it was not possible to establish the direction of the relationship between the variables. Finally, the two versions of the SENA are not directly comparable as they vary in the number and content of questions because they were adapted to each age group.

Despite these limitations, results suggest that both locus of control and self-control could form valuable interventions in the classroom, through the implementation of socio-emotional development programs, such as cooperative play programs and emotional intelligence, which can promote the development of social and emotional competencies that may influence control functions (Garaigordobil et al., 2017). A recent review of self-regulatory interventions suggests that they are effective in children and adolescents to improve their mental health, social skills, behavioral problems and performance (Pandey et al., 2018). Currently, Chile promotes mental health in the school environment with various programs such as Skills for Life (Lara et al., 2012; Murphy et al., 2015), which could integrate work with increasing self-control and internal locus of control to improve the effectiveness of mental health interventions.

While classroom-based interventions may contribute to improved mental health outcomes, it is essential to consider broader interventions that can involve the community and family, since internalizing problems are not limited to school settings (Kang and You, 2018). It has been found that parental supervision, whilst children and adolescents are at home, is a determining factor in the development of an internal locus of control, where a warm and nurturing environment is essential. Furthermore, it has also been observed that harsh discipline is associated with the development of an external locus of control (Ahlin and Lobo Antunes, 2015). This implies the need to support the family in parenting strategies.

Future research, of a longitudinal nature, could address the possible variation in time, both in locus of control and self-control and its relationship with internalizing and externalizing problems, which would support the findings of Sullivan et al. (2017) in relation to locus of control and its effect on depression, and expanding them to include other internalizing problems and self-control. It would be desirable to use random selection and include other regions of Central and Southern Chile, which could

better investigate how minority groups score on the variables. Evaluating interventions that are aimed at increasing internal locus of control and self-control are essential in the promotion of mental health of young people.

CONCLUSION

Both locus of control and self-control showed a relationship with each dimension of internalizing and externalizing problems, with depression having the strongest association among the internalizing problems, and attention among the externalizing problems. The study results suggest that both self-control and locus of control might have an influence on internalizing and externalizing problems and we therefore recommend them to be included in mental health interventions for children and adolescents both inside and outside the school context.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité Ético Científico de la Universidad de Tarapacá. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JF: conception and design of research, preparation of the introduction of the manuscript, data collection, data analysis, and discussion of the manuscript. AC-U: conception and design of research, preparation of the introduction of the manuscript, and discussion of the manuscript. CR: preparation of the introduction of the manuscript, data collection, and discussion of the manuscript. GA and JC: preparation of the introduction of the manuscript and data collection. All authors contributed to the article and approved the submitted version.

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REVIEW
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Does Epilepsy Have an Impact on Locus of Control?

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Many chronic diseases impair patients' quality of life and may also affect their control perceptions. This could particularly happen for patients with epilepsy whose seizures often imply loss of control as a deeply disturbing experience. In 1980, a study on learned helplessness in epilepsy found a highly significant reduction of internal general locus of control (GLOC) and an increase of chance and powerful others health-related LOC (HLOC). In consequence, LOC became a frequent target of investigations relating to depression and anxiety, quality of life, coping, compliance, and other psychosocial aspects of epilepsy. Both GLOC and HLOC were investigated, and special groups like children, elderly, mentally handicapped persons, and those with psychogenic non-epileptic seizures were addressed. Most studies attempted to relate in-group differences of LOC to other parameters. Seizure-free patients were found to have a more internal HLOC, and patients with severe epilepsies have a more external HLOC. Patients with a high external HLOC seem to have more difficulties with coping and to be more anxious. Whereas external GLOC was correlated with learned helplessness, internal GLOC was associated with high self-efficacy and better life quality. An association of external LOC with depression seemed not to be a stable co-relation as clinical improvement following epilepsy surgery dissociated the two. A hypothesis was confirmed that the ability of some patients to counteract seizures at their onset, thus preserving control, was correlated with a higher internal HLOC. Some other theoretically well-founded hypotheses were not supported. Absolute figures as reported in several papers are of limited use because the only normative data for comparison come from a local sample of 1976 from Tennessee, whereas LOC scores may differ largely dependent on cultural and societal conditions. Very few controlled studies exist, and the early finding of a generally externalized LOC in epilepsy was confirmed only in one study performed in a South Indian community known for strong stigma against epilepsy. A recent transcultural investigation conducted in Brazil and Lithuania found no differences from healthy controls and between countries. It seems worthwhile to further investigate relations of LOC with epilepsy stigma.

Keywords: epilepsy stigma, seizure control, transcultural studies, epilepsy exclusion, quality of life, learned helplessness, chronic illness, religiosity and epilepsy

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INTRODUCTION

Many chronic diseases have an impact on people's quality of life (QOL) and may also affect their control perceptions. Since epileptic seizures often imply an objective loss of control, the assessment of control perceptions of epilepsy patients is relevant. To rate these, Rotter (1966) has developed the concept of internal versus external locus of control (LOC), and a 29-item scale to measure it. To review the literature studying LOC in epilepsy, we searched in PubMed for MeSH topics (Epilepsy) AND (Locus of control) and supplemented the retrieved manuscripts by all references that could be extracted from them.

Locus of control in epilepsy was first investigated by DeVellis et al. (1980) in the United States who, in a study on learned helplessness in 286 individuals with epilepsy, addressed the hypothesis that seizures, especially when they were frequent, severe, and difficult to predict and control, would result in reduced internal control over outcome and possibly increased depression. Both general LOC (GLOC) and health-related LOC (HLOC) were assessed. For HLOC, the Multidimensional Health Locus of Control scales (form A) of Wallston et al. (1978) (henceforth abbreviated as W78) were used that distinguish between internal, chance, and powerful others control. For GLOC, they applied scales that had been developed by Levenson (1973) as a "modification of Rotter's (1966) Internal–External Locus of Control scale in order to measure more accurately expectancies of control as they relate to adjustment and clinical improvement." The Levenson scales likewise distinguish internal, chance, and powerful others control. They had in fact served as a model for the development of the W78 scales. To reduce the test material, the Levenson powerful others scale was omitted in the DeVellis et al. (1980) study because it had been shown to be moderately correlated with the chance scale. All LOC findings in patients were compared with a normative sample of 115 chance individuals recruited in 1976 at Nashville Municipal Airport as reported by Wallston et al. (1978). The patients showed a significant reduction in internal GLOC and increase in chance HLOC, whereas internal and powerful others HLOC and chance GLOC did not differ significantly from the normative sample. The authors performed a hierarchical-regression analysis where they tested for (1) auras (i.e., initial seizure symptoms that are consciously perceived by the patients as a "warning" of the seizure), (2) believes to be able to avoid or terminate a seizure voluntarily, (3) relation of seizures to certain situations, (4) seizure severity and several other parameters. The regression analysis revealed that having auras and the belief of being able to prevent or stop a seizure were associated with increased internal GLOC and HLOC and decreased depression. Predictability of seizures was correlated with higher internal HLOC, whereas increased severity, early onset, and longer duration of epilepsy were associated with lower internal HLOC but increased chance and powerful others LOC, as well as increased depression.

With these findings, externalization of LOC in epilepsy was considered an established fact, and LOC instruments were in consequence often applied in epilepsy both in children and adults.

STUDIES OF HEALTH-RELATED LOCUS OF CONTROL

Several studies on LOC in epilepsy focused on HLOC because they were particularly interested in the impact of control perceptions on disease-related parameters (**Table 1**).

Soon after the DeVellis et al. (1980) paper, Rosenbaum and Palmon (1984) looked into the influence of helplessness and resourcefulness on coping with epilepsy. Fifty patients with epilepsy of three grades of severity (according to the frequency of generalized tonic−clonic seizures) were divided into a high-resourceful (HR) and a low-resourceful (LR) group according to their scores on Rosenbaum's Self-Control Schedule. This instrument was used as a measure for learned resourcefulness, i.e., individual tendencies to apply self-control methods to the solution of behavioral problems. State and trait anxiety and depression were assessed by established instruments, and HLOC was measured by an earlier (1976) version of W78, supplemented by a scale constructed *ad hoc* for perception of control of seizures. Coping was rated by the Acceptance of Disability scale developed by Linkowski. Half of the patients each belonged to the HR and LR groups. There was no control group. The authors found that HR patients were less depressed and anxious. Their coping was more successful than in LR patients, but only as long as seizure frequency was low to moderate. If it was high, there was no difference. HR patients had a more internal HLOC and a higher perception of seizure control. No independent correlation of HLOC and coping success was reported.

As part of the development of the Liverpool seizure severity scale, Smith et al. (1991) studied the psychosocial consequences of seizure frequency and severity, and external LOC was one of the investigated parameters. Due to a mistake in references, it is unfortunately not clear what scale was applied on the 100 patients with focal epilepsies who were included. Probably it was the Rotter (1966) scale. Seizure severity was found to be the most significant predictor of self-esteem ($p = 0.005$), LOC ($p = 0.039$), and anxiety ($p = 0.048$). Of note, the severity scale included some items examining how much control the patients had over their seizures. Seizure frequency had no influence on the variance of psychological factors.

Chovaz et al. (1994) investigated factors influencing the psychosocial function, measured by the Washington Psychosocial Seizure Inventory (WPSI, Dodrill et al., 1980) and a structured interview, after treatment of 42 drug-resistant patients by temporal lobectomy. Resourcefulness, depression, and LOC were assessed as variables of learned helplessness. Psychosocial outcome was better with good seizure control, whereas depression and lack of resourcefulness were correlated with poor psychosocial function. HLOC (W78) had no influence.

Coping was, again, the aspect that was addressed by Krakow et al. (1999). They applied a German version of W78 together with the Freiburg Questionnaire for Coping with Illness, which considers five dimensions of coping,

TABLE 1 | Literature review since 1980.

Authors, year	Country	Subjects (N)	LOC Instruments	Main findings
Seminal study				
DeVellis et al., 1980	United States	286 PWE	W78 Levenson scales for GLOC	• Patients had reduced internal GLOC and increased chance HLOC, whereas internal and powerful others HLOC, and chance GLOC did not differ from normative sample • Having auras and the belief of being able to prevent or stop a seizure were associated with increased internal GLOC and HLOC, and decreased depression
Studies of Health LOC				
Rosenbaum and Palmon, 1984	Israel	50 PWE	Rosenbaum's Self-Control Schedule W78 (modified)	• HR patients had a more internal HLOC and a higher perception of seizure control • HR patients were less depressed and anxious. Their coping was more successful than in LR patients, but only as long as seizure frequency was low to moderate
Smith et al., 1991	United Kingdom	100 patients with medically refractory focal seizures	Rotter's LOC?	• Seizure severity was the most significant predictor of LOC, anxiety and self-esteem
Chovaz et al., 1994	Canada	42 drug-resistant patients submitted to temporal lobectomy	W78	• Psychosocial outcome was better with good seizure control, whereas depression and lack of resourcefulness were correlated with poor psychosocial function • HLOC had no influence on psychosocial outcome
Krakow et al., 1999	Germany	40 patients with intractable epilepsy	IPC-questionnaire measuring generalized LOC	• The use of coping patterns, which were regarded as maladaptive, was correlated with distinct depression, a small degree of internal LOC beliefs and poor psychosocial adaption
Spector et al., 2001	United Kingdom	100 PWE (uncontrolled seizures)	W78	• No significant differences in the internal and chance scales whereas patients identified as low controllers believed more in control by powerful others • Higher internal and lower powerful others HLOC scores were associated with lower depression scores, and higher internal HLOC was associated with higher learned resourcefulness and higher self-esteem
Gramstad et al., 2001	Norway	101 PWE	W78	• The hypothesis that HLOC is of importance for the psychosocial functioning in patients with epilepsy was not supported by this study
Au et al., 2002	Hong Kong	67 with active epilepsy	W78	• Chance HLOC was the only one which correlated with health-related QOL • Health locus of control and the satisfaction with social support confirmed the importance of the influence of the subjective sense of mastery of condition on quality of life
Asadi-Pooya et al., 2007	United States	200 PWE (60 seizure-free)	W78 (form C)	• PWE had weak perceptions of internal and strong perceptions of external HLOC • Higher internal LOC was related with being seizure free. Patients with higher powerful others rating had increased anxiety levels, whereas no correlation with depression was found
Lohse et al., 2015	Denmark	49 PWE	W78 (form C)	• Ability to react to an aura prior to a seizure relates to higher internal HLOC but not to levels of anxiety and depression
Studies of General LOC				
Hermann and Wyler, 1989	United States	37 PWE submitted to neurosurgical treatment	Rotter's LOC	• Preoperatively there was a correlation between external LOC and depression. Postoperatively, depression improved associated with seizure freedom, LOC did not change
Hermann et al., 1990	United States	102 PWE (uncontrolled seizures)	Rotter's LOC	• External LOC showed a significant relationship with the general health
Gehlert, 1994, 1996	United States	143 PWE	Rotter's LOC W78	• Perceptions of control were conceptualized as learned helplessness for bad, but not for good, events. The hypothesis that individuals who continue to have seizures become more and more external in perceptions of control was not confirmed
Amir et al., 1999	Israel	89 PWE	Rotter's LOC	• Ninety percent of the variance of the WHO-QOL was explained by a combination of disease severity, self-efficacy in epilepsy, social support, and locus of control
Gopinath et al., 2000	India	200 PWE	Rotter's LOC (modified)	• Most patients had an external locus of control, which negatively influenced their compliance

(Continued)

TABLE 1 | Continued

Authors, year	Country	Subjects (N)	LOC Instruments	Main findings
Yeni et al., 2016	Turkey	70 PWE	Rotter's LOC	• LOC correlated with anxiety and depression, but did not correlate with patients' attitudes toward epilepsy, epilepsy knowledge, quality of life and stigma
Moritz et al., 2018	Brazil and Lithuania	186 PWE 189 healthy controls	Rotter's LOC	• GLOC score did not differ between patients and controls nor between Brazilians and Lithuanians • Having auras, reacting to them and being able to avoid seizures had no effect on any GLOC score but on QOL and anxiety
Children				
Matthews and Barabas, 1986	United States	15 children with epilepsy 15 children with diabetes 15 healthy children	MMCPC	• Children with epilepsy displayed the greatest perception of an external source of control relative to other children (not significant)
Elderly				
McLaughlin et al., 2010	Australia	64 PWE ≥ 60 yo	Rotter's LOC	• More external LOC, which did not predict impaired health-related quality of life
Mentally handicapped persons				
Espie et al., 1990	Scotland	65 PWE	Nowicki-Strickland LOC scale	• Mentally handicapped adults perceived external control over their environment in view of the lack of autonomy offered to them
Psychogenic non-epileptic seizures				
Moore et al., 1994	United Kingdom	19 PWE 19 PNES 19 healthy volunteers	Levenson scales	• No significant differences were found between the three groups regarding the scores for LOC
Stone et al., 2004	Sweden	20 PWE 20 PNES	Swedish 50-item self-report instrument for assessing LOC	• Patients with PNES had a more external locus of control
Strutt et al., 2011	United States	30 women with PNES 51 women with temporal lobe epilepsy	W78 (form C)	• PNES patients had a higher score on significant others HLOC, but no general differences in health-related LOC

GLOC, general locus of control; HR, high-resourceful; LR, low-resourceful; MMCPC, Connell's multidimensional measure of children's perception of control; PNES, psychogenic non-epileptic seizures; PWE, persons with epilepsy; QOL, quality of life; W78, Wallston's health-related locus of control scale (1978).

von Zerssen's scale for state depression, and the Social Interview Schedule for psychosocial adaptation. Forty patients with uncontrolled seizures were included. The authors were particularly interested in the relations of different coping strategies. They found that a high score of powerful others HLOC was correlated with religiousness/search for meaning, dissimulation/wishful thinking, and depressive coping, but also with an integrating scale of ineffective coping. Chance HLOC beliefs were correlated with unfavorable social management, and patients with a low internal LOC tended to have maladaptive coping patterns.

Spector et al. (2001) returned to the question of resourcefulness and divided their 100 patients with uncontrolled seizures into a high controller (HC) and a low controller (LC) group. This was unequivocally possible only in 79 subjects of whom 58 belonged to the HC, and 21 to the LC group. They wanted to replicate the findings of Rosenbaum and Palmon (1984) and, in addition, to clarify what strategies the patients applied to control seizures. Instruments applied were W78, the Hospital Anxiety and Depression Scale (HADS), and Rosenberg's self-esteem scale. The control strategies were assessed in a semi-structured interview based on six questions referring to both facilitating and counteractive factors of seizures.

(1) Have you noticed any situations or states that will cause you to have more seizures?
(2) Have you ever got yourself into any of these states on purpose, knowing you will probably have a seizure?
(3) Have you ever encouraged a seizure to come (can you bring on a seizure)?
(4) Are there any situations or states in which you have fewer seizures?
(5) Do you sometimes make yourself have fewer seizures (e.g., by avoiding seizure precipitants)?
(6) Can you sometimes stop your seizures from happening?

Whereas affirmative answers to the first three (facilitator) questions were similar in the HC and LC groups, HC patients gave significantly more positive answers to questions 4–6 (counteractive). LC patients were more often women, were more likely to have focal seizures with impaired awareness, and significantly more often identified one or more seizure precipitants. Regarding HLOC, there were no significant differences in the internal and chance scales, whereas LC patients believed more in control by powerful others. Higher internal and lower powerful others HLOC scores were associated with lower depression scores, and higher internal HLOC was associated with higher learned resourcefulness and higher self-esteem. Higher

age and longer duration of epilepsy were correlated with higher powerful others HLOC.

The authors had expected to find that "the occurrence of warnings would enable people to abort their seizures more readily and hence be associated with high perceived self-control. This prediction was not borne out by the present data." However, near-reading the article does not show that this question was tested directly. The conclusion seems, rather, to have been indirect: affirmative responses to questions 4–6 "were the main behaviors contributing to the probability of being in the HC group" but HC was not related with higher internal or lower chance HLOC, only with lower significant others HLOC. The wording in the article is compatible with this but cannot be understood to mean that the prediction was refuted. In addition, the data did not allow telling if patients' attempts at aborting seizures reduced their seizure frequency and whether this had an influence on their control perceptions.

Gramstad et al. (2001) in Norway investigated the hypothesis that negative and positive affectivity, self-efficacy, and HLOC are important for psychosocial adjustment in patients with epilepsy. They included 101 patients who were tested with W78 and the WPSI (Dodrill et al., 1980), an extensively and cross-culturally validated instrument to measure psychosocial adjustment in patients with epilepsy. It has seven distinct dimensions and one summary measure of overall social function. In addition, the positive and negative affect schedule (PANAS-X), and established scales for general and epilepsy-related self-efficacy were included. The Wallston scale has three dimensions (internal, chance, and powerful others) with six items each that apply a Likert scale of 1–6. Thus, every item has a possible range of 6–36. The scores found were (mean ± SD) 22.71 ± 5.48 for internal, 19.37 ± 6.2 for chance, and 21.06 ± 6.25 for powerful others. In comparison, the normative data for healthy adults of W78 are 25.37 ± 5.32 for internal, 16.23 ± 6.28 for chance, and 20.23 ± 5.49 for powerful others. All figures thus indicated externalized HLOC in the patients, but the standard deviations were large, and the study had no control group. Regarding intercorrelations between the measures studied, they were good for affects, self-efficacy, and clinical items of WPSI, whereas correlations with HLOC were low or insignificant. The authors concluded that "the hypothesis that HLOC is of importance for the psychosocial functioning in patients with epilepsy was not supported by this study."

Au et al. (2002) reported on the QOL in Hong Kong Chinese adults with epilepsy. They investigated health-related QOL (HRQOL) with the QOLIE-89 and HLOC with W78. In addition, the HADS and a social support questionnaire were applied. Sixty-seven patients with active epilepsy were enrolled. The HLOC scores were 24.97 ± 4.79 for internal, 18.87 ± 6.48 for chance, and 25.63 ± 5.08 for powerful others. Of these, chance HLOC was the only one that correlated with HRQOL but only weakly and as long as the data were not controlled for the influences of mood.

Asadi-Pooya et al. (2007) investigated the relationship between HLOC and anxiety, depression, and seizure control in 200 patients of an outpatient clinic and an epilepsy monitoring unit at Thomas Jefferson University, Philadelphia (United States). Sixty patients were seizure-free, the others not. They applied the more recent form C of W78, which was developed to be adaptable to specific health conditions (Wallston et al., 1994), together with the HADS. HLOC scores were 19.6 ± 6.3 for internal, 17.7 ± 6.4 for chance, and 24.4 ± 5.4 for powerful others. There was no control group, and for this form, there are no normative data. Stepwise regression revealed some associations. A higher internal LOC was significantly related with being seizure–free, whereas the two other subscales were not associated with seizure control; patients with higher powerful others rating had increased anxiety levels, whereas no correlation with depression was found. The authors conclude that the powerful others LOC in these cases relates to a higher need for advice to deal with their anxiety: "Physicians should be aware of their strong role in determining their patients' health-related beliefs and behaviors and be more solicitous of their thoughts and desires. Further studies are required to better clarify the significance of patient–physician communication in this regard and how HLC may be related to improving the management of patients with epilepsy."

Lohse et al. (2015) tested the hypothesis that patients whose seizures start with an aura to which they can react in a meaningful way would experience less loss of control by seizures and have a more internal LOC. Of 98 eligible patients, 49 participated in the study. They submitted per mail an aura questionnaire, the HAD scale, and form C of Wallston's HLOC scale. This was followed up by a semi-structured telephone interview. Twenty-eight reported auras to which they could react. The others had no auras or could not react. Aura experiences as such had no significant correlation with any HLOC scores, but patients who had auras and could react to them scored 22.0 (17.3–26.0) on internal HLOC, the others 14.0 (11.0–22.5, $p = 0.017$). They also scored lower on the chance and powerful others scale, but these differences were not significant. Both groups did not differ in the anxiety and depression measures, which were within the normal range. The hypothesis was, thus, confirmed.

To conclude, some studies confirmed low internal or high external LOC scores for patients with epilepsy compared with a normative sample, whereas no controlled studies exist. A positive correlation of auras and possibilities of counteracting seizures with internal LOC, as reported by DeVellis et al. (1980) was confirmed by one study, whereas another had an equivocal conclusion. More internal scores were found in seizure-free patients and those with high resources, whereas more severe seizures predicted external HLOC. HLOC was not correlated with psychosocial functions after neurosurgical treatment of epilepsy, and correlation with life quality was questionable. High external HLOC was correlated with ineffective and maladaptive coping, and increased anxiety in patients with a high powerful others HLOC was reported in one study but denied in another.

STUDIES OF GENERAL LOCUS OF CONTROL

Another series of studies investigated general LOC to find whether the frequent experience of loss of control by unexpected seizures would affect control perceptions not only relative to health but to life in general (**Table 1**).

Authors were often primarily interested in the correlation of within-group differences of LOC in epilepsy patients in relation with other psychosocial aspects, without reporting the patients' LOC data.

Hermann and Wyler (1989) studied the relation between external LOC (using Rotter's external–internal scale) and depression in 37 patients who underwent neurosurgical treatment for epilepsy. Preoperatively, there was a correlation between external LOC and depression. However, whereas depression was found significantly improved 6 months postoperatively in the 22 individuals who were rendered seizure-free, the LOC did not change, contrary to the authors' expectation. LOC seemed, thus, to be much less dependent than depression upon the present state of health. They conclude that LOC is a learned phenomenon acquired over the entire lifetime. Patients had suffered from epilepsy in average for 18 years, and it was perhaps unreasonable to expect a change after only 6 months without seizures.

The same group (Hermann et al., 1990) assessed the psychiatric status of 102 patients with epilepsy using Goldberg's General Health Questionnaire. They investigated the possible predictive value of many factors for psychopathology, and external LOC (measured with the 1966 Rotter internal–external scale) was one of seven identified variables found ($p = 0.017$). However, after stepwise multiple regression analysis, it was not retained as an independent variable.

Gehlert (1994, 1996) pointed out that externality of control and learned helplessness had become included in multietiologic, theory-based models of psychosocial problems in epilepsy, but these models had never been tested. The existing empirical studies had shown an association of externality of control and learned helplessness with epilepsy but not given insight into the nature of these associations. Her study therefore addressed the hypothesis that seizure-free individuals would have more internal control perceptions than those still having seizures. To take care of the time factor in the development of control perceptions either way, an "index of seizure control" was calculated as seizure-free years divided by present age minus age at epilepsy onset. It was a questionnaire study mailed to 782 patients, with 143 (22%) completed and returned. The instruments used were the Rotter scale for internal vs. external LOC, W78, and the Attributional Style Questionnaire of Peterson et al. (1982) for learned helplessness. The main hypothesis was not confirmed for either GLOC or HLOC, only attributions as helplessness for bad events were significantly reduced in relation to the index of seizure control. LOC and learned helplessness did not appear isomorphic.

In a different approach by Amir et al. (1999), GLOC was along with the Self-Efficacy Scale (SES), both in Hebrew adaptations, considered as dimensions of mastery that, together with social support, could mediate between disease severity (measured with the Liverpool Seizure Severity Scale) and QOL. Life quality of 89 patients with active epilepsy was determined with the WHO Quality of Life questionnaire (WHOQOL). "Ninety percent of the variance of the WHOQOL was explained by a combination of disease severity, self-efficacy in epilepsy, social support, and locus of control. Mastery was found to mediate the correlation between disease severity and QOL, and social support was found to act as a mediator between disease severity and mastery." More internal LOC was correlated with higher self-efficacy and higher QOL.

Gopinath et al. (2000) in Kerala, South India, investigated 200 patients with epilepsy using the Rotter scale (1966) in a version standardized and validated for the local population. Their answers were categorized as internal, intermediate, or external using the 33rd and 67th percentile of a control group of 206 healthy adult volunteers. The I-E score (mean $\pm$ SD) of the patients was 0.355 ± 0.214 compared with 0.287 ± 0.204 in the control group ($p < 0.001$), and the majority of patients (45.2%) had a score above the 67th percentile.

These authors were interested in the relation of LOC, doctor–patient communication, and compliance with prescribed medications and advice about adequate behavior. For assessment of communication and compliance, they used a semi-structured interview following the consultation based on a self-developed questionnaire. There was a significant positive correlation between a good doctor–patient communication and good compliance. In bivariate analysis, non-compliance was correlated with more external LOC ($p = 0.022$), whereas in multivariate analysis, this trend did not reach statistical significance.

Yeni et al. (2016) studied the attitudes of 70 Turkish epilepsy patients toward epilepsy and found that these were primarily influenced by knowledge about epilepsy, stigma, depression, and related with QOL. GLOC was assessed with a validated Turkish version of the Rotter (1966) instrument where they had an average score of 10.5 ± 3.32 (no control group). LOC did not appear correlated with patients' attitudes.

As a consequence of our earlier study (Lohse et al., 2015) that had shown that patients' ability to react meaningfully to auras was correlated with a higher internal score on Wallston's HLOC scale (form C), Moritz et al. (2018) wanted to know if the same was true for GLOC. The idea behind was that the repetitive experience to be able to avoid loss of control by seizures would provide a higher perception of self-control not just regarding their epilepsy but for their lives in general. A transcultural study was conducted comparing control perceptions in Brazil and Lithuania. The two countries belong both, in general terms, to the well-developed democratic Western societies but at the same time differ in other important respects: Brazil belongs to the "rising economies" of the Southern hemisphere, with strong traditional religious attitudes and a still only moderately developed middle class. Lithuania belongs to the Northern hemisphere, has a strongly secularized society and recently experienced the societal revolution of a move from the Soviet Union to the European Union.

Being aware of some methodological issues of LOC research, the authors decided to apply the original internal–external LOC scale of Rotter (1966) but included healthy controls for comparison. The scale consists of 29 questions where participants have to choose between two opposing statements representing an internal or external view.

The score is given as the sum of all answers indicating an external view. As six questions serve as distractors, the scale reaches from 0 (maximum internal LOC) to 23 (maximum external LOC). In addition, the HADS and QOLIE-31

were applied as the well-established instruments for anxiety, depression, and QOL in epilepsy. Religiosity was assessed with the Index of Core Spiritual Experiences-Revised (INSPIRIT-R). Data were collected in parallel in both countries separately using the same procedures. A total of 186 patients and 189 controls were recruited. 111 patients were enrolled in Lithuania and 75 in Brazil. The results were surprising: the GLOC score differed neither between patients (9.56 ± 3.46) and controls (8.96 ± 3.34) nor between Brazilians (9.08 ± 2.87) and Lithuanians (9.88 ± 3.79). Patients had a lower level of education and lower social status; they had a higher rate of unemployment and a higher score on the depression scale. Brazilians had a shorter education, were more religious, and scored higher for anxiety.

Having auras, reacting to them and being able to avoid seizures had no effect on any GLOC score, which makes sense as these were not deviant anyway. However, patients with auras had a lower life quality and a higher level of anxiety (perhaps because they are more aware of their seizures), but this difference disappeared when they had the experience of being able to actively avoid seizures.

To conclude, controlled studies confirmed high external GLOC of patients with epilepsy in South India in 2000 but not in Brazil and Lithuania in 2018. Apparent correlations of external LOC with increased psychopathology and non-compliance were not confirmed in multiple regression analysis, and there was no correlation of GLOC with patients' attitudes about epilepsy. Whereas external GLOC was correlated with learned helplessness, internal GLOC was associated with high self-efficacy and better life quality. A correlation between external LOC and depression that is indicated in several studies disappeared after successful epilepsy surgery because depression improved rather rapidly, whereas external GLOC did not.

LOCUS OF CONTROL IN SPECIAL GROUPS

Children

Matthews and Barabas (1986) in a much quoted study tested 15 children with epilepsy with Connell's Multidimensional Measure of Children's Perception of Control (MMCPC) and compared them with two age-matched groups of 15 each, children with diabetes and healthy controls. Additional instruments used were the Piers–Harris Self-Concept Scale, the Draw-a-Person test, and the Rochester Adaptive Behavior Inventory. They reported that "children with epilepsy invariably displayed the greatest perception of an external source of control relative to other children." However, the figures show that, in the overall means, the figures of the children with epilepsy were only slightly above diabetes, and statistical difference was only found for "unknown source of control" between both chronically ill groups and the healthy controls, whereas the figures for powerful others were small and showed no statistical differences at all. Thus, the findings with this small sample may perhaps have been overinterpreted.

Elderly

McLaughlin et al. (2010) studied the impact of epilepsy on the QOL of older people in Australia. Sixty-four community-dwelling individuals aged 60 or above were included. The HRQOL instrument QOLIE-31 was applied as well as the Composite International Diagnostic Interview (CIDI)-Auto, a computerized, structured interview, for the detection of depression and dysthymia. Seizures were categorized as "partial" versus "generalized" onset, with four categories of frequency. GLOC was measured with the scale of Rotter (1966) and gave a score of 13.28 ± 4.08. This might indicate more external LOC, but there was no control group. Contradictory to expectations, external HLOC did not predict impaired HRQOL.

Mentally Handicapped Persons

Espie et al. (1990) investigated LOC in mentally handicapped persons in Scotland. Their prediction was that people with the double burden of seizures and mental handicap would display a higher amount of external LOC. They set out to investigate "the effects of polypharmacy and seizure frequency upon psychosocial behavior and examine locus of control orientation in a community sample of mentally handicapped adults with epilepsy." Of the 65 subjects included, 21 had a high frequency of more than one seizure/month (HF), the others a lower frequency (LF). Psychosocial behavior was assessed with a psychosocial behavior scale (PBS) that had been previously developed by the authors. It indexes the frequency and intrusiveness of problematic behaviors. For LOC, the Nowicki and Strickland (1973) LOC scale for children (1973) was applied in a subgroup of patients forming three matched groups of nine individuals each for comparison: HF patients, LF patients, and controls with no history of epilepsy. The 40-item scale is based upon Rotter's internal vs. external concept, and higher scores likewise indicate more externality. Maximum scores are not mentioned. Regarding drug regimes, monotherapy was compared with polytherapy. HF patients received more commonly polytherapy and LF patients, monotherapy ($p < 0.001$). Problematic behaviors were more frequently observed in patients with HF and on polytherapy. The LOC scores were 17.4 ± 4.3 for the whole sample, 16.88 ± 4.64 for HF, 15.77 ± 3.66 for LF, and 19.44 ± 4.12 for non-epilepsy controls. The differences were not statistically significant. Thus, LOC seemed to depend more on mental handicap with its restrictions in autonomy than on seizures and antiepileptic drugs.

Psychogenic Non-epileptic Seizures

The purpose of the Liverpool study of Moore et al. (1994) was to "examine the role of pseudoseizure behavior in fulfilling a function within the family context." They compared three groups of 19 individuals each with epilepsy, psychogenic non-epileptic seizures (PNES, "pseudoseizures"), and healthy volunteers. Instruments applied were the Family Environment Scale, the HADS, Rosenberg's self-esteem scale, and for GLOC, the Levenson scales. Of the three LOC scales, only internal LOC was marginally lower in the two seizure groups (13.2 each) than in the control group (14.3), but the difference was not statistically significant.

Stone et al. (2004) compared illness beliefs and LOC of patients with epilepsy and with PNES, both recently diagnosed after a minimum of two seizures, and attending one of two Swedish university hospitals, in a prospective case-control study. For illness beliefs, a Swedish translation of the Illness Behavior Questionnaire was used, and for LOC, a Swedish 50-item self-report instrument. In this, "forty items referred to locus of control orientation with an equal distribution between internal and external directions. The items relate to the concept of locus of control for life events rather than health-specific locus of control. Ten items were adapted from the Karolinska Scales of Personality to measure the degree of social desirability in patients." In each group, 20 patients were recruited, and there were no healthy controls. Significant differences were that patients with PNES mostly believed in somatic causes of their condition, denied life stresses, and attributed all problems to illness, whereas patients with epilepsy were likely to believe in psychological causes of their condition. The former had a moderately but significantly more external LOC.

Strutt et al. (2011) focused on women with PNES looking for "factors that may potentially aid in the differential diagnosis and subsequent tailoring of treatment." Thirty patients were diagnosed with PNES and 51 with temporal lobe epilepsy, and areas assessed were motivation, HRQOL, disturbances of mood, and HLOC. Instruments were the Beck depression and anxiety inventories, MMPI, QOLIE-89, and form C of the Wallston et al. scale for HLOC. The PNES patients had a higher score on significant others HLOC ($p = 0.007$).

To conclude, all three studies agree that an increased external or decreased internal LOC in patients with PNES was the only difference from patients with epilepsy to be found.

METHODOLOGICAL ISSUES

Investigations of LOC in epilepsy have applied multiple instruments, which make comparisons sometimes difficult. The original one-dimensional internal–external scale of Rotter (1966) is still in use, although it was soon modified by Levenson (1973) into an instrument with three dimensions (internal, chance, and powerful others LOC). This was further developed into a health-related instrument, the W78 with two alternative forms A and B. Wallston et al. (1978) provided normative data for these scales that were based on a chance sample of 115 persons who were encountered at an airport in Nashville, Tennessee, in 1976. Levenson (1973) had a different group of 96 normal controls about whom little is known and which was not referenced later. Their scores, however, were not identical with the Nashville sample, for chance LOC even quite dissimilar. Later, Wallston et al. (1994) developed a form C of W78, which is adaptable to multiple health conditions and has no normative data.

Based upon these traditional instruments, some authors developed adaptations into other languages and cultures or developed their own instruments. The reason may have been that not all items of the original instruments work well in non-United States societies. Thus, Lohse et al. (2015) in Denmark worked with Wallston et al.'s (1994) form C, translated, back-translated, and acknowledged by Wallston. They noted that due to linguistic differences, some patients did not take all questions seriously. Thus, the item "If I am lucky, my epilepsy will get better" in Danish wording sounds like a meaningless commonplace.

For special groups, such as children and individuals with mental handicaps, separate scales were obviously needed and developed.

Numerical values of LOC were given in some studies where they could only be related to normative values from the abovementioned sample of people met at an airport in Nashville, Tennessee, in 1976. Most of the studies were performed so remote from that sample, both in time and space, that these values are not applicable.

Even as the majority of investigators were not interested in absolute values but in correlations of in-group variances of LOC with other parameters, the scarcity of controlled studies is surprising. In fact, only five such studies exist, one of them a small and unrevealing study in mentally handicapped people (Espie et al., 1990). The investigation of Matthews and Barabas (1986) compared small samples of children with epilepsy and diabetes with healthy controls and showed more external LOC in chronically ill children, with a non-significant trend toward more externality in children with epilepsy. Moore et al. (1994) compared three groups (patients with epilepsy, patients with PNES, and healthy controls) and found a non-significant trend toward lower internal LOC in both groups with seizures. The study of Gopinath et al. (2000) in South India compared 200 patients with 206 healthy controls using a locally adapted and validated version of the Rotter (1966) scale. They found a highly significant externalization of LOC in the patients.

In contradistinction, Moritz et al. (2018) in a controlled transcultural study with the Rotter (1966) scale detected no differences in GLOC between patients and controls, and between the two participating countries, Brazil and Lithuania.

As has been repeatedly noted, LOC is a learned concept developing slowly during life and reacting slowly to even important changes of life conditions (Hermann and Wyler, 1989). It is to an important extent dependent on a person's life situation and ambience. This has been impressively shown by Smith et al. (1995) who created, from 1983 and 1993, a databank of 9,140 responses to the Rotter (1966) scale from employees in business organizations in 43 countries. The country averages ranged widely from 6.35 (Pakistan) to 12.69 (German Democratic Republic). The contrast of the latter with West Germany (8.35) was striking, as the populations of the two (now reunited) countries were in many respects homogeneous but divided by a liberal versus a totalitarian political system. As was discussed earlier (Moritz et al., 2018), the scores were high, expressing external LOC, in almost all of the included highly controlling communist countries (Bulgaria, China, Czechoslovakia, East Germany, Hungary, Poland, Romania, USSR, and Yugoslavia). The point is that "several questions in the scale address success in school and professional life, which in these countries often depended more on compliance with the political system than on one's abilities." What was intended to reveal purely subjective perceptions of control turned thus, in these countries, into a

description of objective facts with the effect of externalizing the GLOC score. Other relevant aspects beyond individualist vs. collectivist cultures according to Smith et al. (1995) include Christianity vs. religions believing more in fate, but also the demographic composition of nations. Well-matched control groups are, therefore, indispensable whenever generic data about LOC in specific conditions like epilepsy are intended.

Moritz et al. (2018) also proposed another possible factor working toward a "normalization" of LOC scores in epilepsy over time, i.e., reduction of stigmatization of epilepsy due to public awareness campaigns. Repetitive opinion polls measuring public attitudes to epilepsy in several countries such as Czech Republic (Novotná and Rektor, 2017) and United States (Cui et al., 2015) have shown a development toward more inclusion. Unfortunately, studies of the influence of stigma on LOC in epilepsy are largely missing so this remains at present a hypothesis. It is noteworthy, however, that in the same South Indian society, where a significantly externalized LOC was found by Gopinath et al. (2000), public attitudes toward epilepsy at the same time were strongly stigmatizing and excluding (Radhakrishnan et al., 2000).

CONCLUSION

The question whether epilepsy has an impact on LOC is not easy to answer on the background of studies with the commonly used instruments. Findings suggesting that epilepsy as such is associated with externalized control perceptions (DeVellis et al., 1980; Matthews and Barabas, 1986) were not methodically robust even if they may have some validity for the United States in the 1980s. They were strongly confirmed for South India by Gopinath et al. (2000) but could, in a transcultural investigation, not be reproduced for countries as far apart as Brazil and Lithuania Moritz et al. (2018). The latter findings seem to indicate that epilepsy as such has no appreciable impact on LOC. Possible accessory reasons for externalization of LOC in epilepsy such as living in a stigmatizing, excluding society have not been sufficiently investigated.

On the other hand, investigations of relative in-group differences of HLOC and GLOC have found some associations. Patients who experience seizure warnings and can meaningfully react to them have a more internal HLOC. Seizure-free patients have a more internal HLOC, and patients with severe epilepsies have a more external HLOC. Patients with a high external HLOC seem to have more difficulties with coping and are perhaps more anxious. Whereas external GLOC was correlated with learned helplessness, internal GLOC was associated with high self-efficacy and better life quality. An association of external LOC with depression seemed not to be a stable co-relation as clinical improvement following epilepsy surgery dissociated the two. Likewise, HLOC was not postoperatively correlated with psychosocial functions. That certain apparent correlations such as external LOC with increased psychopathology and with non-compliance were not confirmed as an independent variable in multiple regression analysis is perhaps not so surprising. LOC seems to be a composite function resulting from multiple factors and as such not a *prima vista* candidate for an independent variable. The correlations may still be interesting.

These findings are not spectacular, and some hypotheses in relation to LOC and epilepsy could also not be confirmed. Thus, the investigations of LOC in epilepsy overall have perhaps not quite lived up to expectations, and there is today less enthusiasm about the topic than there was some decades ago. On the other hand, studies of societal influences like stigmatization and discrimination of epilepsy could provide new interesting data.

AUTHOR CONTRIBUTIONS

PW drafted the manuscript and wrote the final version. KL organized the Brazilian arm of the transcultural study on which important conclusions are based, received the invitation to this review and organized it, and edited the draft and approved the final version. RM organized the Lithuanian arm of the transcultural study on which important conclusions are based, and edited the draft and approved the final version. RW made substantial contributions to the draft and approved the final version. All authors contributed to the article and approved the submitted version.

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REVIEW
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Reorienting Locus of Control in Individuals Who Have Offended Through Strengths-Based Interventions: Personal Agency and the Good Lives Model

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Having an external locus of control has been associated with a range of well-supported risk correlates of offending behavior. Further, individuals with an internal locus of control orientation are suggested to be more open to engaging in treatment and are also considered more likely to have successful treatment outcomes. In forensic settings, where individuals are subject to external controls and have little personal autonomy, it is important to consider what treatment approaches might be most successful in reorienting individuals' locus of control. The Good Lives Model (GLM) proposes a strengths-based approach to the rehabilitation of individuals who have offended. Within the GLM, an external locus of control is suggested to be associated with a deficit in the primary good of agency. In this article, we will provide a brief overview of the literature on locus of control and its hypothesized role in offending behavior. We will discuss how an external locus of control orientation is related to personal agency and how strengths-based models, such as the GLM, may assist with reorienting locus of control in individuals who have offended through promoting personal agency.

Keywords: agency theory, Good Lives Model (GLM), locus of control, rehabilitation, offending

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INTRODUCTION

Rotter (1966) defines locus of control as the degree to which a person perceives an outcome as being contingent on their own actions or those of external forces, existing along a continuum from a more internalized orientation to a more externalized orientation. Individuals who hold the belief that outcomes are dependent on their own behavior or personal characteristics are said to have an internal locus of control. In contrast, those with an external locus of control believe that life outcomes are determined by forces outside of their control (e.g., independent of their own actions or as a result of fate, luck, or chance), are dependent on powerful others, or are unpredictable due to the complex nature of the social environment.

The development of locus of control orientation is described within the context of Rotter's (1954) social learning theory, where future outcome expectancies for specific or seemingly related events are strengthened through reinforcement. Individuals' own experiences and reinforcement history are hypothesized to be related to the extent to which they attribute outcomes to their own actions (i.e., a more internalized or more externalized orientation). Thus, attitudes, beliefs, and

expectancies associated with an individual's locus of control orientation are suggested to develop, be reinforced, and strengthen through their interactions with others, the environment, as well as individual differences (e.g., cognitive development, feelings of alienation or powerlessness, need for autonomy or active mastery of the environment, and need for achievement; Rotter, 1966).

Rotter's (1966) construct theory of locus of control has proved highly popular in the psychological literature, attracting much attention from researchers. However, while the construct of locus of control has garnered much attention over the years, it has been noted that over time "...the concept of locus of control or reinforcement may have become untethered from its original social learning theoretical roots" and that there has been a "proliferation of similar sounding terms" (Nowicki and Duke, 2017, p. 148). The different ways in which locus of control orientation has been operationalized within the forensic psychological literature provides one example of this.

Locus of control is of interest to forensic practitioners due to its relationship with well supported risk correlates for offending behavior (i.e., crime) and factors associated with treatment success (e.g., treatment readiness, engagement, and improvement on areas of need). However, within the forensic literature, locus of control has been operationalized in two, arguably distinct, ways. In some instances, locus of control has been operationalized similarly to Rotter's (1966) definition, with an externalized locus of control relating to feelings of being a passive agent where events and consequences are perceived to be outside of the individual's control, and an internalized locus of control related to feelings of empowerment and the ability to control or influence events and outcomes (e.g., McAnena et al., 2016). In contrast, other literature has defined or used locus of control as a proxy measure for accountability (i.e., the extent to which individuals take responsibility for their actions and behaviors; Beech and Fisher, 2002; Page and Scalora, 2004) and denial (Fisher and Beech, 1998). This second conceptualization is arguably more related to individuals' *post hoc* reasoning about their offending and in this sense is vulnerable to cognitive processes such as justification or attempts to distance themselves from their misdeeds, as opposed to being a true reflection of their locus of control orientation generally. Therefore, it is somewhat misaligned with the social learning theory approach originally purported by Rotter, as it risks ignoring reinforcement experiences of individuals that may impact upon their beliefs relating to control and outcome expectancies, as well as their capacity for autonomy or self-direction.

Rotter (1966) suggests an individual's motivation for autonomy or agency is likely to influence the strength of their outcome expectancies and therefore locus of control orientation. Personal agency refers to "an individual's capacity for, and engagement in, intentional, goal-directed action" (Heffernan and Ward, 2017, p. 134) and the cognitive, affective, and individual learning experiences that influence this. Recent theoretical explanations of offending and rehabilitation have considered the role of autonomy and personal agency in human behavior (e.g., Heffernan and Ward, 2015, 2017; Thornton, 2016). Given the hypothesized relationship between locus of control orientation and agency, we suggest it may be helpful to consider how increasing an individual's capacity for agency may also help to reorient an individual's locus of control.

In this paper, we will first provide an overview of the hypothesized relationship between locus of control, offending behavior, and rehabilitation. We will then discuss how locus of control and personal agency are related and how it may be helpful to target the shared properties of these constructs (e.g., need for autonomy) in forensic treatment, as opposed to simply focusing on an individual's ability to take responsibility for their actions. Finally, we will examine how strengths-based approaches to rehabilitation such as the Good Lives Model (GLM; Ward and Stewart, 2003) may help to reorient locus of control through increasing an individual's personal agency. To ensure consistency with Rotter's (1966) definition of locus of control, we have focused our review on empirical studies that have defined or measured locus of control using either Rotter's (1966) Internal–External Control Scale or the Nowicki-Strickland Locus of Control Scales (Nowicki and Duke, 1974a,b), both of which were constructed to reflect Rotter's original definition within his social learning theory (Nowicki and Duke, 2017).

LOCUS OF CONTROL AND OFFENDING BEHAVIOR

Research has examined the association between locus of control orientation and offense-related variables including correlates of offending, treatment engagement and change, and recidivism. Individuals who have offended tend to report having a more externally oriented locus of control than non-offending individuals, with this finding replicated across both adult and adolescent samples and a range of behaviors, including sexual offending (e.g., Beck-Sander, 1995; Wood and Dunaway, 1997; Marsa et al., 2004), drunk driving (e.g., Cavaiola and Desordi, 2000), parents "at risk" of child abuse (e.g., Ellis and Milner, 1981), and shoplifting (e.g., Kelley, 1996). Further, within offending populations, individuals who have been involved in interpersonal violence (e.g., violence, sexual offending) have been found to have a more externalized locus of control compared to non-violent offending controls (Hollin and Wheeler, 1982; Marsa et al., 2004). Individuals with an external locus of control are also reported to be more likely to reoffend than those with an internal locus of control (Ollendick et al., 1980; Fisher et al., 1998; Halliday and Graham, 2000; Stevens et al., 2016; Tidefors et al., 2019). Thus, reorienting an individual's locus of control to a more internalized direction appears to be an important target for rehabilitative programs.

Correlates of Offending Behavior

Although individuals who have offended appear to be more likely to have a more externally oriented locus of control compared to non-offending individuals, this alone is unlikely to directly account for offending behavior. An external locus of control has been found to be associated with a range of well-supported risk

factors for offending. More specifically, a more external locus of control has been associated with deficits in social competency (e.g., social skills, problem-solving ability, attachment style; Veneziano and Veneziano, 1988; D'Zurilla and Maydeu-Olivares, 1995; Marsa et al., 2004; Allan et al., 2007), coping (Carton and Nowicki, 1994; Gomez, 1997, 1998), self-esteem (Asberg and Renk, 2014), the presence of offense supportive attitudes (Allan et al., 2007; Chambers et al., 2008), and substance misuse (Cavaiola and Desordi, 2000).

Further, research from the general psychological literature suggests that an internal locus of control may function as a protective factor or psychological buffer (Page and Scalora, 2004). For example, several studies have reported that, compared to those with an externally oriented locus of control, individuals with a more internalized locus of control report significantly higher levels of self-esteem (Griffore et al., 1990), emotional and mental well-being (Armstrong and Boothroyd, 2007), adaptive coping (Kliewer and Sandler, 1992), and a more positive self-concept (Friedberg, 1982; Wood et al., 1996).

Limited research has examined the exact mechanism through which locus of control orientation influences psychological processes and physical behaviors, particularly in relation to offending. However, some researchers have hypothesized that an external locus of control may be linked to cognitive distortions (e.g., attributing blame to others for offending or viewing the self as uncontrollable; Chambers et al., 2008), increased impulsivity (e.g., lack of consequential thinking; Fisher et al., 1998), and may act as a defensive response to feelings of shame (McAnena et al., 2016). For example, perceived locus of control may shift toward a more external orientation following offending as the individual wishes to distance themselves from the behavior to retain a positive sense of self or avoid feelings of guilt. However, it is unclear whether cognitive distortions (e.g., justification, shifting blame, etc.) are actually reflective of locus of control orientation or whether they are an attempt to distance the self from certain behaviors (i.e., locus of control might generally be more internalized).

Research examining the relationship between locus of control and self-esteem suggests that, together, these factors may moderate psychological and behavioral outcomes. For example, Wallace et al. (2012) examined the relationship between self-esteem, locus of control, and self-reported aggression in a sample of 174 adolescents enrolled in a voluntary residential program. Wallace et al. (2012) found that higher levels of self-esteem were significantly associated with an internally oriented locus of control and that locus of control orientation moderated the relationship between self-esteem and self-reported aggression (both reactive and proactive). Further, Wallace et al. (2012) found that the combination of low self-esteem and an external locus of control was significantly related to higher levels of self-reported proactive aggression. In another study, Kliewer and Sandler (1992) examined locus of control and self-esteem as moderators between negative life events and psychological well-being in 238 young people. Kliewer and Sandler (1992) found that an internal locus of control orientation acted as a buffer to the effects of negative life events on psychological well-being. Further, the combination of an external locus of control and low self-esteem was associated with higher levels of psychological maladjustment.

LOCUS OF CONTROL AND REHABILITATION

Treatment Readiness, Engagement, and Outcomes

A more internalized locus of control orientation has been linked with key factors associated with successful rehabilitation including treatment readiness (Chambers et al., 2008), amenability and engagement with treatment (Page and Scalora, 2004), and successful treatment outcomes (Fisher et al., 1998). Chambers et al. (2008) reviewed the literature on the influence of cognition on treatment readiness and engagement in rehabilitation for those who have committed violent offenses. They suggested that locus of control orientation is likely to influence individuals' motivation and decision to change their behavior. More specifically, they argued that an external locus of control is likely to reduce a person's commitment to behavior change and therefore their motivation and engagement in rehabilitative activities, as they are unlikely to perceive these as relevant or meaningful. Similarly, Page and Scalora (2004) reviewed the literature relating to locus of control, help-seeking, treatment participation, and treatment outcomes in young people who had offended and concluded that an individual's locus of control orientation prior to treatment may provide an indication of their amenability to engage—with an external locus of control indicating a low level of treatment amenability. Empirical research supports these conclusions; for example, Groh and Goldenberg (1976) report an association between an internal locus of control orientation and engagement in prison-based occupational and educational programs.

While locus of control orientation is considered to be relatively stable (Rotter, 1966), research examining the effects of psychotherapeutic interventions on locus of control suggests that there is a dynamic quality to the construct, in that it is responsive to a range of interventions (i.e., it can be reoriented; Hunter, 1994; Newton, 1998; Page and Scalora, 2004; McAnena et al., 2016). In addition to being malleable to treatment itself, it has also been suggested that locus of control is associated with broader treatment success. For example, Fisher et al. (1998) examined the relationship between locus of control orientation and overall improvement on a range of outcome measures, administered pre–post treatment as part of a sexual offending treatment program. Fisher et al. (1998) reported that participants who were considered to have been "successfully treated" (i.e., had made a significant overall improvement on the battery of pre–post treatment measures) showed a significant shift toward a more internal locus of control pre–post treatment compared to those considered "unsuccessfully treated" (i.e., those who had not made a significant overall change). This finding suggests that rehabilitative activities that help to successfully reorient locus of control to a more internalized direction may also bring about broader improvements in other areas.

Impact of the Criminal Justice System on Locus of Control Orientation

As noted above, locus of control orientation appears to be both responsive to intervention and important for bringing

about change in other areas. However, forensic settings are arguably not the most conducive environments for supporting individuals to develop beliefs consistent with a more internalized locus of control. The very nature of imprisonment, detention, or community supervision restricts personal autonomy. For example, decisions about routine, recreational activities, sentence progression, and release back to the community are often outside of individuals' control and dependent on powerful others. To illustrate, risk and parole board decisions rely on professionals' opinions and input, and attendance at educational courses, offense-focused group rehabilitation, and work placements are reliant on the decisions of other people.

Further, time spent in prison is known to have a considerable impact on individuals' psychological and emotional well-being. For example, longer stays in prison have been found to be associated with low self-esteem, depression, and reduced problem-solving abilities (Pugh, 1993), which, as noted above, are also associated with a more externalized locus of control. In addition, reduced outcome control has been associated with the development of "learned helplessness," feelings of powerlessness (Goodstein et al., 1984), and weaker beliefs in free will (Rakos et al., 2008). Therefore, it has been argued that forensic environments may potentially promote and sustain an externally oriented locus of control by providing further reinforcing experiences (Kappes and Thompson, 1985). While impinging on agency is inherent within the practice of imprisonment, we are concerned that these restrictions may have the unintended consequence of reducing a person's sense of personal agency in such a way that he or she may not perceive that change is possible (e.g., reinforce a more externalized locus of control), thereby undermining the goals of the criminal justice system. Given the apparent effects of forensic settings on both locus of control and agency, we will now consider the relationship between these two constructs.

LOCUS OF CONTROL AND PERSONAL AGENCY

As outlined above, a number of overlapping and offense-related concepts associated with locus of control exist. Further, there are close conceptual relationships between locus of control and human capacities that have recently been theoretically linked with offending and rehabilitation; for example, self-control or self-regulation and concepts such as autonomy, motivation, free will or choice, and personal agency. Agency allows individuals to have control over their lives, to experience self-determination, and to feel as if they are acting without restriction or coercion. We suggest that locus of control orientation may reflect *an individual's perception of their own capacity for agency* (e.g., "to what extent am I capable of engaging with the world to meet my various needs/goals?"), which in turn is supported by their perceptions of and expectations of their environment (Heffernan and Ward, 2017). This perception is informed by past experiences and other messages the individual has received about themself and their world (Rotter, 1966). For example, if a person experiences many opportunities to meet their needs/goals, others are supportive, they are competent/successful, and so on, they are likely to develop an internal locus of control and perceive that they are in control of their life and capable of dealing with situations that arise. On the other hand, where individuals experience the world as dangerous, full of others who wish to control them, lacking opportunities for them to meet their needs, and so on, they are likely to develop an external locus of control and feel powerless over their own life. This may result in an individual giving up and concluding that everything will always be this way (e.g., believing "there is no point trying to change as what happens to me is outside of my control, so I will only fail") or developing new strategies in order to increase control over their life (e.g., creating illegal opportunities or attempting to control others). Due to its centrality within rehabilitation theories such as the GLM (Ward and Stewart, 2003) and recent theories of offending, we will now discuss personal agency and a number of agency-based theories that relate to locus of control. This includes the Predictive Agency Model (PAM; Heffernan and Ward, 2017), Thornton's Theory of Dynamic Risk (Thornton, 2016), the Agency Filter Model (Serin et al., 2016), and theories of desistance (e.g., Sampson and Laub, 2005).

The PAM (Heffernan and Ward, 2017) was developed in response to perceived problems with the way explanations of offending tend to assume causality of dynamic risk factors or correlates of offending (e.g., antisocial attitudes, personality pattern). This model provides a general explanation of goal-directed behavior and as such is applicable to a range of behaviors (e.g., offending, substance use, desistance/change). The model asserts that behavior is guided by both mental representations held by individuals (informed by past experiences/learning) and emotion. These include the cognitive and emotional aspects of beliefs about the nature of the self, others, and world, as well as specific schemas or scripts relating to particular people or situations. These mental representations guide actions by operating like a template containing information, which is used by the individual to create situation-specific representations in "real time" and use these to make decisions. Decision-making is guided by the three types of expectation depicted in the Theory of Reasoned Action (TRA; Fishbein and Ajzen, 2010), those concerning perceived rewards, others' reactions, and one's own capability. In this model, locus of control would be conceptualized as a mental representation of one's agency as more or less self-determined based on previous experiences. This impacts on decision-making (i.e., the TRA) because it influences whether or not the individual believes he or she is capable of acting to achieve a certain outcome.

Thornton (2016) (in his Theory of Dynamic Risk) suggests that behavior is motivated by a particular need or goal and that schemas are used as information to help the individual make a decision about how to act. These decisions are guided by expectations of one's own abilities, likelihood of reward, and how others are likely to respond (i.e., the TRA; Fishbein and Ajzen, 2010). This theory was later applied to protective factors (those associated with desistance from crime) that are largely conceptualized as the inverse of risk domains; they are "families of related constructs" (Thornton et al., 2017, p. 30). There are four

types of protective factor: internal, social support, professionally provided, and openness to professionally provided. Thus, this model sees protective factors as internal capacities (i.e., self-control, empathy, hope) and their manifestation within various arenas of life (Thornton et al., 2017), for example, influencing how open an individual is to engaging with professional support such as rehabilitation. Like the PAM, this model would conceptualize locus of control as a schema (or belief) influencing individuals' perceptions of their capacity to bring about outcomes (or engage in successful agency), and it could be risky or protective depending on its orientation.

The Agency Filter Model (Serin et al., 2016) is another offense-focused theory that aims to explain the influence risk and protective factors have on an individual. This model suggests that individuals (at least to some extent) are able to choose how they react to external conditions (i.e., those that increase/decrease risk). These authors highlight the internal conditions that facilitate desistance from crime, and this includes hope, optimism, psychological flexibility, and self-efficacy (Serin et al., 2016). The "filter" that characterizes this model consists of an individual's attitudes toward offending/desistance and the attributions they make about events that could lead to each (i.e., the meaning attributed to gaining employment, losing a relationship, etc.). This model would likely conceptualize locus of control as an important part of the "agency filter" containing beliefs about one's own capacity for agency and attributions of outcomes/events as being internally or externally caused. For example, individuals with an internal locus of control who obtain employment might attribute this to their own hard work and efficacy and believe that, if they work hard, they will be able to progress and have a rewarding career, whereas individuals with an external locus of control might attribute this to luck and believe they are just as likely to lose this job through no fault of their own. These beliefs are likely to lead to different behaviors at work and will influence whether or not employment acts as a protective factor against offending for a particular individual. This highlights the importance of locus of control for the desistance process.

Desistance can be defined as the process of moving from active offending to reduced frequency/severity of offending, and eventually stopping offending altogether (Maruna, 2001). A number of mechanisms have been discussed as central to this process, both life events (e.g., employment, marriage) and personal shifts in identity and priorities (e.g., cognitive transformation and knifing off the past; Sampson and Laub, 2005). The internal changes associated with desistance are likely to be easier when one has an internal locus of control, for example, the transformation of one's identity from "offender" to "non-offender" relies on one's perceived ability to act differently in the face of external conditions (i.e., stressors and opportunities to offend). One cannot change their identity and behavior if they are not in control of the way they respond to external pressures and others' expectations. Further, when encountering external support or events that often accompany the desistance process (e.g., employment or education opportunities, prosocial relationships and support, becoming a parent, etc.) an internal locus of control may facilitate prosocial responses.

Given the theoretical relationship between locus of control, agency, and offending, understanding and influencing an individual's locus of control orientation are particularly important in forensic settings. The things that incarcerated individuals are able to control are limited, even choices about whether or not to make prosocial changes are influenced by the requirement that they engage with treatment in order to complete their sentence requirements and gain parole. Individuals who are incarcerated or on sentences in the community are expected to change, to become less criminal if they are to be released and/or trusted to reintegrate into society. It is not enough that an individual has served their time; they are also expected to demonstrate that they pose less risk to society than they did previously. Rehabilitation can be more or less coerced, ranging from mandated interventions, to those that involve various degrees of coercion (e.g., withholding privileges, denial of parole), to those that are completely voluntary (Parhar et al., 2008). More coercive rehabilitative activities have the potential to reinforce an external locus of control orientation. Thus, even when individuals have internal or intrinsic motivation to change, this motivation (and internal locus of control) may be undermined by outside pressures (e.g., coercion), known as the "undermining effect" (Ryan and Deci, 2000b). It is suggested that intrinsic motivation results in changes that last longer as they are not controlled by external conditions (Ryan and Deci, 2000a). In fact, research has found programs that are more coercive or mandated are less effective (in terms of reducing recidivism) than those that are voluntary, regardless of setting, suggesting that intrinsic motivation is more strongly associated with successful treatment outcomes and longer lasting change (Parhar et al., 2008).

Finally, even if individuals do decide change would be beneficial, if they do not feel they possess agency over their life, they are unlikely to feel motivated or competent enough to change. Because individuals undergoing forensic treatment are already likely to feel their autonomy is lacking, it is even more important that development of an internal locus of control is prioritized during preparation to make changes. With this in mind, the following section will explore interventions with individuals who have committed offenses that aim to shift their locus of control perception toward a more internal orientation, with a particular focus on strengths-based approaches (i.e., those that aim to increase individual's skills and capacity to lead a meaningful and prosocial life).

REORIENTING LOCUS OF CONTROL USING STRENGTHS-BASED APPROACHES

Strengths-based approaches represent a relatively recent development in forensic psychological practice and arose in response to criticisms of more traditional rehabilitation models, such as the Risk-Need-Responsivity (RNR) model (Bonta and Andrews, 2017). The RNR model is a prevailing rehabilitation framework in the criminal justice system and contends that treatment is likely to be most effective when it is matched to the

risk level, criminogenic needs, and personal characteristics of the individual (Bonta and Andrews, 2017). The RNR approach has amassed a body of empirical support; however, it has also been criticized as being "deficit oriented," primarily concerned with risk management, external controls, and teaching individuals to avoid risky situations (Seligman and Peterson, 2003; Ward and Maruna, 2007; Ward et al., 2012). In comparison, strengths-based approaches encourage the building of strengths or resources necessary to create a personally meaningful and satisfying life, rather than just the avoidance of risk (Ward and Gannon, 2006). Strengths-based approaches are considered to be complementary to RNR (e.g., should be used alongside core principles). It is also suggested that additional attention to agency and self-efficacy may act to further decrease the risk of reoffending (Ward et al., 2007).

A number of strengths-based interventions for offending have been described in the literature, many of which are derived from the GLM (Marshall et al., 2017). While these interventions may vary in the extent to which they adhere to GLM principles, many incorporate proxies of a GLM approach (Willis and Ward, 2013; Marshall et al., 2017). Given this, in the following section, the GLM and its potential for promoting agency and a more internally oriented locus of control will be discussed.

STRENGTHS-BASED TREATMENT: THE GOOD LIVES MODEL

The GLM (Ward and Stewart, 2003; Ward and Gannon, 2006) is a strengths-based rehabilitation model that encourages the building of strengths or resources necessary to build a good life, rather than just the avoidance of risk. The GLM is based on the assumption that offending, like all human behavior, is motivated by primary human goods (valued states or ways of being, such as happiness, inner peace, mastery, relatedness, autonomy, creativity, etc.). Persons have different ways of meeting these needs based on their own personal capacities and the external resources or opportunities available to them. For example, one might meet their need for autonomy through having an academic career where they are free to choose what they wish to research, while another may exercise autonomy through moving out of their parents' home or leaving a controlling relationship. It is problems with attaining these goods that lead to harmful or offending behavior, for example, problems with the means used (i.e., they harm others) or conflict between different needs. For instance, if a person feels unable to meet his or her need for autonomy generally, he or she may engage in self-destructive behaviors to regain some sense of control (e.g., restrictive eating, self-harm, substance abuse) or he or she may attempt to control others through the use of violence, coercion, or intimidation. In overly restrictive contexts, such as prison, an individual may have very limited means available to meet a range of needs, including autonomy.

It has been suggested that one of the aims of antisocial/criminal behavior can be to demonstrate personal agency and control when individuals perceive they lack this in other aspects of their lives (Maruna, 2001), making this an important part of rehabilitation. Locus of control orientation is often not directly addressed as part of interventions for offending (e.g., through a specific module or dedicated sessions), and this is also true of GLM-informed interventions; instead, a whole program approach is proposed to support individuals to develop a more internally oriented locus of control through promoting agency and building skills. This extends from the underlying aims and ethos of the treatment program to the assessment process and the intervention content and delivery (Willis et al., 2012). In the following sections, we will discuss the mechanisms through which GLM-informed interventions promote personal agency and reorient locus of control. We will also highlight how strengths-based approaches like the GLM may prove helpful in forensic contexts, where opportunities to exert autonomy are restricted and experiences reinforcing an external locus of control are likely to be prevalent (see **Table 1** for a summary).

TABLE 1 | Impact of forensic environment on agency and locus of control and application of risk reduction vs. strengths-based approaches.

Features of forensic environment	Impact on agency and locus of control	Risk reduction interventions	Strengths-based interventions
Coerced rehabilitative activity (e.g., expected to engage to gain parole).	Undermine motivation to change through lack of agency.	Assumes capacity for agency already exists.	Collaborative treatment planning and goal setting. Use GLM to identify areas of treatment need. Positive therapist features (e.g., genuine, warm, unconditional positive self-regard, challenging). Develop capacity for agency through marking progress toward personal goals. Transparent communication.
Lack of control over routine, associates, food choices, etc.	Restrict personal choice. Increase feelings of disempowerment, loss of control.	May reinforce restrictions through setting avoidance goals and focus on external constraints.	Setting approach goals rather than avoidant goals. Having a flexible approach to treatment. Collaborative decision-making.
Incapacitation–restriction of movement and removal from society.	Loss of freedom. Limited control over external environment.	May reinforce incapacitation through "risk removal" approach.	Adopting a holistic approach to treatment—focusing on areas relevant to reducing risk as well as those that are important to the individual. Setting and working toward personally meaningful goals including those that can be achieved within the secure environment and steps that can be taken toward goals within this setting.

Good Lives Model and Treatment Goals

The GLM is grounded in the ethical concepts of universal human rights and human dignity (Ward and Syversen, 2009). This is seen in the strong emphasis placed on human agency (Purvis et al., 2011; Willis et al., 2012). In GLM-informed rehabilitation programs, this focus on agency is seen throughout both the assessment and treatment process through the emphasis placed on supporting individuals to identify personally meaningful goals, working collaboratively to develop a plan for achieving these goals in a prosocial manner and giving individuals the space to implement their life plans (Willis et al., 2012).

The treatment goals of GLM-consistent interventions are also aligned with promoting agency. Historically, offense-focused rehabilitation efforts have been primarily focused on the management of risk and with that has come a focus on avoidance goals (Fortune et al., 2012). This means that the focus has been on individuals *avoiding* specific high-risk states and situations. For example, a goal for someone who has sexually offended against children might be to avoid places where children congregate, such as schools and parks, or avoiding feeling lonely, which may increase his or her risk of using the internet to access child exploitation materials. It has been argued that this focus on avoidance goals negatively impacts upon the engagement and motivation of individuals (Fortune et al., 2012; Fortune, 2018). In contrast, strengths-based rehabilitation approaches focus on approach goals, those that move an individual toward valued outcomes. For example, rather than attempting to avoid children or feelings of loneliness, an individual might have the goal to develop close friendships with peers (i.e., building a support system and social skills). In both cases, risk may be reduced, but in the approach goal scenario, the individual is focused on moving toward a valued outcome (i.e., relatedness) rather than avoiding risk. In GLM-informed rehabilitation programs, this means that the emphasis is on supporting individuals to identify approach goals that are personally meaningful and developing the capacity and competency to achieve these. The goal of therapy is to equip individuals with the skills, knowledge, resources, and supports necessary for them to realize their goals in socially acceptable ways, without causing further harm to themselves or others. Treatment also supports individuals to ensure balance in their life plan and that they reduce any conflict that might exist between their various life goals.

The GLM's collaborative approach to identifying personally meaningful goals and developing an individualized plan to achieve these is one key strategy for promoting agency and empowering individuals. Within the pretreatment assessment, emphasis is placed on identifying what individuals hold most important in life through identifying the primary goods that are prioritized by them, how they have gone about attaining these previously, and identifying problems or obstacles with achieving these (Willis et al., 2012; Barnao, 2013). From this, a personalized good lives rehabilitation plan can be developed, outlining the individual's goals and the steps needed (both in prison and upon release) to achieve these (for an example of good lives goal planning, see Barnao, 2013), which in turn informs case formulation and treatment planning (Willis et al., 2012). Adopting a collaborative person-centered approach from the outset helps to promote client agency and encourage the development of a more internalized locus of control, empowering individuals by enabling them to have input into their own treatment when in an environment within which they have little autonomy. Further, following assessment, clients are informed that the aim of treatment (or the treatment plan) is to support them with developing the skills and resources needed to achieve their goals and lead a life that is personally meaningful, while also reducing their likelihood of reoffending (i.e., to develop the means to have control over life outcomes through prosocial goal seeking; Willis et al., 2012).

Good Lives Model Treatment Content and Delivery

The GLM approach has been found to have a positive impact on treatment motivation and engagement (Mann et al., 2004; Gannon et al., 2011), something which has been found to be low in individuals with a more externalized locus of control (Page and Scalora, 2004; Chambers et al., 2008). Further, it has been suggested that building motivation increases belief in justice-involved individuals that their goals are attainable (i.e., that they are achievable and that they have control over how they attain these; Fortune, 2018).

As noted earlier, GLM-consistent treatment programs promote agency not only through their aims, orientation, and pre-assessment but also through the way in which content is presented and delivered. An important component of GLM treatment is to support individuals to develop their understanding about how best to achieve their goals (Fortune, 2018). A GLM approach to treatment would seek to support individuals to develop skills to increase capacity for agency (e.g., understanding and managing emotions, problem-solving) and identifying and supporting engagement with opportunities that result in mastery and a sense of agency being achieved without using harmful actions (external capacities; i.e., education, leisure, or work programs in areas of existing interest, skill, knowledge, or ability) (Langlands et al., 2009; Fortune et al., 2015).

For example, McAnena et al. (2016) explored the role of locus of control and its relationship to treatment outcomes in a sample of 185 males who were referred to a non-GLM community treatment program for sexual offending (The Challenge Project). A more externalized locus of control was significantly positively correlated with risk scores on the STATIC-99 risk assessment measure (Hanson and Thornton, 2000). Further, locus of control was found to significantly shift from a more external to a more internal orientation post treatment. From this, McAnena et al. (2016) concluded that locus of control represents a potentially meaningful measure of treatment change. Subsequently, The Challenge Project treatment program was revised to include a greater emphasis on empowerment (agency) through increased collaboration, including providing clients with training on completing their own evidence-based risk assessments (Craissati, 2018).

Another core tenet of the GLM approach that promotes agency is the development of a strong therapeutic alliance. Therapist characteristics are known to play an important role in

developing therapeutic rapport. However, the use of constructive and collaborative approaches when delivering treatment has also been reported to evoke intrinsic motivation and autonomy (Marshall and Burton, 2010). Involving individuals who have offended in formulating their offending and treatment needs and identifying ways in which they can achieve their life goals, while simultaneously addressing factors that may act as obstacles to attaining these (i.e., criminogenic needs), can provide individuals with a sense of hope and belief that they can control their life outcomes (i.e., a more internalized locus of control).

The research discussed in this section highlights some of the key ways in which strength-based approaches promote agency and through which they can reorient an individual's locus of control. Through focusing on personally meaningful life goals and adopting a collaborative approach to treatment, GLM-consistent interventions can create opportunities for individuals to develop a more internally oriented locus of control in a restricted environment. In the next section, we will describe studies that have evaluated the efficacy of GLM-informed interventions in reorienting locus of control to examine the effectiveness of these.

Effectiveness of Good Lives Model Approaches in Reorienting Locus of Control

While the GLM is used as a rehabilitative framework internationally, empirical evaluations of GLM-informed/consistent interventions are still in their infancy, with a lack of evaluation of post treatment reoffending (Willis and Ward, 2013; Marshall et al., 2017). That said, a small number of within-treatment evaluations have examined the effectiveness of GLM interventions with locus of control as an outcome measure, as well as an emerging body of research examining the contribution of the different components of the GLM to the desistance process. These studies and their findings will be briefly described here (see **Table 2** for an overview).

In a United Kingdom sample of males convicted of sexual offending, Barnett et al. (2014) found that individuals who completed a GLM-consistent program (n = 202) were more likely to display a "treated profile" post treatment than those in the Relapse Prevention program (n = 321). The determination of a "treated profile" included consideration of scores on five psychometric measures including the Nowicki–Strickland Locus of Control Scale (Nowicki, 1976). In a study of a program for individuals convicted of an internet-related (sexual) offense (i-SOTP) in England and Wales, Middleton et al. (2009) also found a positive relationship between GLM-consistent treatment and locus of control. Participants (n = 264) completed a battery of psychometrics including the Nowicki–Strickland Locus of Control Scale (Nowicki, 1976), with a significant change noted on this scale between pre and post treatment. This change was also noted in other areas of socio-affective functioning (e.g., self-esteem, emotional loneliness, cognitive and motor impulsivity) and pro-offending attitudes (victim empathy and cognitive distortions).

In another example, Gannon et al. (2011) reported preliminary findings from an evaluation of a Good Lives Sexual Offending Treatment Group (SOTG) in the United Kingdom, designed for males experiencing mental health difficulties. Using case study descriptions (n = 5), Gannon et al. (2011) report that, despite their differential and complex needs, participants made progress during the program on some key indicators, including developing a more internalized locus of control. Although all individuals had locus of control scores within the normal range pre treatment, in four out of the five case descriptions, issues related to autonomy were associated with their offending, and in one case description, the individual clearly identified an external locus of control, describing himself as having "little control" over his index offense (p. 163).

In another study, Gannon et al. (2015) evaluated the effectiveness of a GLM-informed treatment program developed for adult males in prison with a history of deliberate firesetting: *The Firesetting Intervention Program for Prisoners* (FIPP; Gannon, 2012). A battery of psychometric assessments was completed pre and post treatment and at 3-month follow-up, which assessed a range of factors associated with deliberate firesetting, including locus of control orientation. Treatment completers' (n = 54) scores on the psychometric measures were compared with those of a comparison group (n = 45) who resided at prisons where the FIPP treatment was not available. Gannon et al. (2015) found that 40.7% of FIPP participants showed a notable change in their locus of control orientation (assessed using individual effect sizes) compared to 33.3% of the comparison group. This effect represented a non-significant trend in favor of the treatment group (p = 0.06) and was maintained at follow-up for FIPP participants but not for the comparison group.

In addition to treatment evaluation studies, there has also been some qualitative research exploring agency, the GLM, and the process of desisting from further offending. Barnao et al. (2015) examined 20 forensic patients' perceptions of rehabilitation using thematic analysis. Agency was identified as one of seven key themes that characterized participants' experiences of the forensic rehabilitative context. More specifically, "a lack of control overshadowed participants' experience of compulsory detention" (p. 1036). Following this, Barnao et al. (2016) explored the impact of a brief GLM intervention using comparative thematic analysis of pre post treatment interviews with five forensic patients. Loss of agency, disempowerment, and feelings of being controlled were reported as key features of participants' lives on the forensic mental health ward pre treatment. However, an increased sense of agency was associated with perceived change post treatment in three out of five participants. Features of GLM treatment such as shared decision-making, transparent communication, progress toward personal goals, and self-determination (e.g., feeling capable of doing positive things for oneself) were identified as contributing toward an increased sense of agency.

Wainwright and Nee (2014) looked at offending and the process of desistance in the Preventing Youth Offending Project (PYOP), a community-based (non-residential) GLM consistent program in the United Kingdom. Interpretative Phenomenological Analysis of semi-structured interviews with seven individuals aged 10–18 years who all started their criminal behavior prior to adolescence, identified four key themes social awareness, self-development, self-hope, and self-identity,

TABLE 2 | Summary of studies examining outcomes for GLM-informed interventions on locus of control orientation.

Author	Intervention	Sample	Measure of locus of control	Outcome
Barnett et al. (2014)	CSOG and TVSOG compared Relapse Prevention version to GLM version	Adult males with a conviction for sexual offending. CSOG (RP) = 163 TVSOG (RP) = 158 CSOG (GLM) = 105 TVSOG (GLM) = 97	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	GLM completers showed a greater shift toward a more internalized locus of control post treatment completed to RP completers. A larger proportion of GLM completers showed a "functional score" on locus of control post treatment than RP completers.
Gannon et al. (2011)	Good Lives Sexual Offender Treatment Group (SOTG) for men with a mental illness	Adult males with a history of sexual offending Treatment = 5	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	Locus of control scores within normative range pre treatment. 3/4 participants showed a small shift toward a more internalized locus of control post treatment.
Gannon et al. (2015)	Firesetting Intervention Program for Prisoners (FIPP)	Adult men and women with a history of firesetting Treatment = 55 Comparison = 45	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	40.7% of FIPP participants showed a notable change in their locus of control orientation compared to 33.3% of the comparison group ($p = 0.06$).
Harkins et al. (2012)	N-SOGP compared Relapse Prevention (RP) version to Better Lives (GLM) version	Adult males with a conviction for sexual offending RP = 701 GLM = 76	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	66% of the GLM participants demonstrated clinical change pre–post treatment on socio-affective measures (including locus of control) compared to 60% of RP participants.
Middleton et al. (2009)	iSOTP	Adult males convicted of an internet based sexual offense Treatment = 264	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	Statistically significant shift to a more internalized locus of control observed post treatment.
Tyler et al. (2018)	Firesetting Intervention Program for Mentally Disordered Offenders (FIP-MO)	Adult men and women with a history of firesetting Treatment = 52 Comparison = 40	Nowicki–Strickland Locus of Control Scale (Nowicki, 1976)	Participants in the treatment group reported a slightly more externalized locus of control post treatment relative to the comparison group.

RP, Relapse prevention; GLM, Good Lives Model.

with self-identity "assuming both a salient and influencing position over the other three" (p. 172). Within these themes, the importance of autonomy, along with relatedness, and competence, were highlighted. In terms of autonomy, those desisting from offending had a belief in their own ability to control their behavior and saw this as a personal choice, rather than being imposed on them by others. For this group, it became clear that developing an internal locus of control was a critical part of the desistance process (Wainwright and Nee, 2014).

It is also important to note that there has been some research that has found little or no association between GLM-informed rehabilitation and changes in locus of control orientation. For example, Harkins et al. (2012) compared the effectiveness of a GLM-informed sexual offending treatment program ($n = 76$) with that of a traditional relapse prevention approach ($n = 701$). Treatment effectiveness was measured by comparing attrition rates and change on participants' pre–post treatment scores across a battery of psychometrics including the Nowicki–Strickland Locus of Control Scale. Harkins et al. (2012) found no difference in the attrition rates between the two treatment modalities. No measure-specific outcomes were reported for locus of control orientation pre–post treatment, however, a slightly higher proportion of participants in the GLM condition reported an improvement on the domain of socio-affective functioning (which included locus of control) compared to those in the relapse prevention condition (66% vs. 60%); however, this difference was not significant. In another study, Tyler et al. (2018) evaluated the effectiveness of a GLM-informed intervention for adults with a history of firesetting and a mental health diagnosis by comparing pre–post treatment psychometric scores on a range of treatment targets (including locus of control) for treatment completers ($n = 52$) with those of a treatment-as-usual comparison group ($n = 40$). Tyler et al. (2018) found that participants in the treatment group showed a larger pre–post treatment shift toward a more externalized locus of control than the comparison group; however, this difference was not statistically significant.

SUMMARY AND CONCLUDING COMMENTS

Justice-involved individuals often present with an externally oriented locus of control that has been associated with a range of issues including well-known correlates of offending, lower levels of motivation and engagement with treatment, and poorer treatment outcomes (i.e., increased risk of offending). Locus of control is related to the human good of agency

or autonomy and is viewed as one of the needs that all individuals prioritize. Justice-involved individuals often lack the relevant internal and external capacities to achieve personal agency. For individuals with low levels of personal agency, or an externally oriented locus of control, strengths-based interventions such as the GLM promote the development of agency using a whole-program approach (from their aims and orientation through assessment and treatment) while also supporting individuals to develop the skills to continue to live a personally fulfilling life. Early research evaluating the effectiveness of GLM-consistent programs suggests that these have the potential to positively reorient agency and locus of control within forensic environments. Given forensic settings may provide experiences that further reinforce an external locus of control, GLM-informed interventions represent a potentially promising way to overcome these barriers and to support locus of control reorientation within this environment. However, despite promising early findings, research evaluating the effectiveness of strengths-based interventions, and more specifically their ability to reorient locus of control, is still very much in its infancy. Therefore, further research is needed before any definitive conclusions can be drawn about the extent to which such approaches may promote personal agency and an internal locus of control above that of traditional risk avoidant approaches.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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REVIEW
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Parental Antecedents of Locus of Control of Reinforcement: A Qualitative Review

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The construct of locus of control of reinforcement has generated thousands of studies since its introduction as a psychological concept by Julian Rotter (1966). Although evidence indicates its importance for a wide range of outcomes, comparatively little research has been directed toward identification of potential developmental antecedents of internal/external expectancies. A previous review of antecedent findings (Carton and Nowicki, 1994) called for more research to be completed, particularly using observational and/or longitudinal methodologies. The current paper summarizes and evaluates antecedent research published in the intervening years since Carton and Nowicki's review. Results largely were consistent with expectations based on Rotter's social learning theory, although there is still a need for researchers to use observational, rather than self-report methodologies, and to include data from non-western cultures.

Keywords: locus of control, Rotter, antecedents, social learning theory, expectancies

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ANTECEDENTS OF LOCUS OF CONTROL OF REINFORCEMENT: A QUALITATIVE REVIEW

Locus of control of reinforcement [LOC] was formally introduced and defined as a psychological construct by Julian Rotter (1966), who posited that an individual with internal control expectancies will perceive events as "contingent upon his or her own relatively permanent characteristics," in contrast to an individual with external control expectancies who "is more likely to perceive an event not to be entirely contingent upon his or her own actions but rather as a result of luck, chance, fate or unpredictable because of the forces surrounding them" (p. 2). Since Rotter's introduction of the concept of LOC, it has become one of the most widely studied personality variables in psychology, with over 5,00,000 "hits" in Google Scholar (Nowicki and Duke, 2016).

Personality constructs such as self-efficacy (Bandura, 1992) and attribution (Abramson et al., 1978; Seligman, 1992) are sometimes used interchangeably with LOC. However, they are different constructs and should be considered separately from Rotter's concept of a generalized expectancy. Briefly, self-efficacy is the degree to which someone believes she or he can perform a behavior (i.e., a performance expectancy), while attribution refers to judgments about causes of past outcomes (Peterson and Stunkard, 1992). Although these constructs have generated considerable research themselves, they are not equivalent to Rotter's concept of a generalized problem-solving expectancy regarding outcomes in one's life (i.e., an outcome expectancy). The present review will focus exclusively on studies using the generalized LOC expectancy construct as presented by Rotter (1954, 1966) within the context of his social learning theory.

Thousands of studies have investigated the relation between LOC and outcomes across a wide variety of domains. Results generally have indicated that in the presence of a range of individual

differences in locus of control, more internal, rather than more external, control expectancies appear to be related to more positive and healthier outcomes (see reviews by Lefcourt, 1966, 1972, 1976, 1981, 1983, 1984; Rotter, 1966, 1975, 1982; Rotter et al., 1972; Phares, 1976; Nowicki and Duke, 2016). However, Rotter (1975) cautioned researchers not to assume internality always to be "good" and externality always to be "bad" in and of themselves, but to also consider the relation between LOC and the given psychological situation.

Unfortunately, in spite of its associations with a large range of significant outcomes, relatively few studies have attempted to identify potential parental antecedents of LOC, even though some half-century earlier Rotter (1966) highlighted the need to obtain such information. By antecedents we refer to those parental factors that precede the development of LOC and which may, through scientific investigation, be shown to have an associative or causal effect on determining one's LOC. Nearly three decades after Rotter's call for research identifying antecedents of LOC, Carton and Nowicki (1994) found fewer than 70 published studies on the topic. They concluded parent contingent delivery of consequences, encouragement of autonomy, and warm/supportive home environments were promising candidates. However, research to that point had relied heavily on small scale, self-report, cross-sectional, and correlational methods that limited the conclusions that could be drawn.

The goal of the current paper is to summarize the results of pertinent studies concerning parental antecedents of LOC published since Carton and Nowicki's review and to critically evaluate whether the findings support Rotter's theoretical assumptions concerning the development of control expectancies. We organize the antecedent literature around three themes: Parenting style, parental LOC, and parent involvement/education/homelife. Our hope is that the summarized information may not only be theoretically relevant, but also useful to those interested in developing intervention programs facilitating the growth of realistic control expectancies, that is consistent with the control available to them in the situation. We begin by briefly describing Rotter's social learning theory and the role LOC is assumed to play in it. Then we evaluate the evidence regarding antecedents of control expectancies vis-à-vis predictions based on Rotter's theory and, based on our evaluation, offer suggestions for future research and advice for those working with children. Consequently, our review focuses specifically on research completed with generalized LOC scales constructed to be consistent with Rotter's concept of a generalized problem-solving expectancy.

ROTTER'S SOCIAL LEARNING THEORY AND LOCUS OF CONTROL OF REINFORCEMENT

Rotter's social learning theory emphasizes the role of expectancies in determining behavior. According to Rotter (1954), behavior "is determined not only by the nature or importance of goals or reinforcements, but also by the person's anticipation or expectancy that these goals will occur. Such expectations are determined by previous experience and can be quantified" (p. 102). As such, an expectancy "may be defined as a probability or contingency held by the subject that any specific reinforcement or group of reinforcements will occur in any given situation or situations" (p. 165). Over time, Rotter assumes such expectancies generalize across situations producing generalized expectancies, one of which is LOC.

More broadly, Rotter's social learning theory attempts to explain behavior, or more specifically, the *potential for behavior*, with three basic variables: (1) Expectancies (E), both general and specific, which represent beliefs regarding the likelihood of a behavior causing an outcome; (2) Reinforcement Value (RV), which is the positive or negative valence of a given outcome based on learning history; and (3) The Psychological Situation, which refers to the individual's subjective interpretation of the contextual situation. The four components can be summarized by the formula, BP = f(E & RV), which indicates Rotter's assumption that the potential for a behavior to occur is a function of the expectation the behavior will produce the outcome and the value of the outcome for any given psychological situation (Rotter, 1954).

RESEARCH ON ANTECEDENTS OF LOCUS OF CONTROL OF REINFORCEMENT

Having reviewed the basic components of Rotter's theory, we move to describe and qualitatively analyze the relevant past quarter century of research concerned with identifying antecedents of his LOC construct. We begin with research investigating parenting style and children's LOC. Please see **Table 1** for a list of all studies cited in the current review organized by antecedent category.

Parenting Style and Children's Locus of Control

Parents presumably play a significant role in LOC development because they are largely responsible for selecting learning experiences for their children. The development of LOC expectancies particularly appears to depend on the degree to which parents consistently and, most importantly, contingently reinforce children's behavior-outcome sequences. As Rotter (1966) theorized, "As an infant develops and acquires more experiences, (s)he differentiates events which are causally related to preceding events and those which are not" based on learning behavior-reinforcement contingencies (p. 2).

An influential researcher of parenting, Baumrind (1991) described categories of parenting styles that have been used in several studies examining antecedents of LOC. In general, she defined parenting styles by the degree to which parents provide nurturance, but also set limits, for their children. She identified three primary styles: Authoritarian, authoritative, and

TABLE 1 | References by antecedent.

Antecedent	References
Parenting Style	McClun and Merrell, 1998; Khayyer, 2003; Lin and Lian, 2011; Wickline et al., 2011; Almajali, 2012; Keshavarz et al., 2013; Ahlin and Lobo Antunes, 2015
Parent LOC	Davis and Phares, 1969; Loeb, 1975; Ollendick, 1979; Chandler et al., 1980; Barling, 1982; Ackerman and Ackerman, 1989; Hoffman and Levy-Shiff, 1994; Schneewind, 1997; Tully et al., 2016; Nowicki et al., 2018b
Parent Involvement/Education/Home Life	Bryant and Trockel, 1976; Enger et al., 1994; Yates et al., 1994; Carton et al., 1996; Carton and Nowicki, 1996; Carton and Carton, 1998; Post and Robinson, 1998; Lynch et al., 2002; Khayyer, 2003; Clark et al., 2004; Cohen et al., 2008; Furnham and Cheng, 2016; Roazzi et al., 2016; Golding et al., 2017; Nowicki et al., 2018b

permissive. Authoritarian parents are controlling and tend to use more punitive disciplinary tactics to correct their children. In contrast, authoritative parents set limits, but also display affection, support, and autonomy building practices with their children. In the third style, permissive parents emphasize affection and support, but are relatively "hands off" and de-emphasize discipline and corrective instruction in guiding their children. Results of her studies often indicated that authoritative parenting produced more positive outcomes in children than the other two styles (Baumrind, 2013), leading many LOC researchers to hypothesize that authoritative parenting might be associated with the development of internal control expectancies.

A large scale prospective longitudinal study provides data in support of the hypothesis that parenting style predicts children's LOC. Wickline et al. (2011) used data from a national cohort study of 12,463 children born during one week in England, Scotland, and Wales and their mothers (Osborn et al., 1984). Mother-child dyads were surveyed at the time of the child's birth and again at 5 and 10 years of age. LOC was measured by an Anglicized Children's Nowicki-Strickland Internal External scale (Nowicki and Strickland, 1973). Analyses showed warm supportive family structures and non-authoritarian parenting styles were associated with children's internality. In addition, a previously unidentified activity, parents reading daily to their children, was an especially significant activity at 5 years of age that predicted greater internality at age 10. To be sure of any causal linkage, LOC should have been assessed at age 5 as well as at age10, but this possible association is a candidate for future research.

Cross-sectional studies also provide support for associations between parenting style and LOC. For example, McClun and Merrell (1998) reported eighth and ninth grade children who perceived their parents as authoritative had greater internality and more positive self-concepts than those who perceived their parents as authoritarian. Similarly, Almajali (2012) found authoritative parenting was associated with greater internality, while authoritarian parenting was associated with greater externality in a group of preparatory school children in Jordan.

In sum, most research suggests that harsh, controlling parenting is associated with children's externality and authoritatively warm, supportive parenting with children's internality. However, some research (e.g., Keshavarz et al., 2013) from non-Western cultures has suggested the possibility that authoritarian parenting may be related to internality if children perceive it as being supportive (see also Lin and Lian, 2011). Authoritative parenting, which includes fostering autonomy in a supportive manner, appears to provide an environment conducive for a child to effectively experience behavioral contingencies, where their own actions are perceived as causally related to outcomes. In contrast, authoritarian parents may inhibit such learning because they themselves control the outcomes to a greater degree in their children's lives. In a different fashion, permissive parents also may fail to provide an adequate environment for the learning of contingencies. Even though permissive parents are characterized as loving, their relative lack of structure, discipline, and involvement may not serve to foster the contingency learning that Rotter suggested was central to how internal expectancies develop.

Parent Locus of Control as Antecedent to Children's Locus of Control

Besides parenting styles, parents' actual LOC may be a significant antecedent to children's LOC, but this hypothesis has not received much attention. Based on the assumption that children often model their parents' attributes, some researchers have predicted that children's LOC will be similar to that of their parents.

However, results of most self-report, cross-sectional studies of the possible relationship between parent and child LOC have found little or no association (Davis and Phares, 1969; Loeb, 1975; Barling, 1982; Ackerman and Ackerman, 1989; Hoffman and Levy-Shiff, 1994; Morton, 1997). When an association has been found, it has been either: (1) gender related, with parent LOC being associated with daughters', but not sons', LOC (Ollendick, 1979) or (2) parent related, with mothers, but not fathers', LOC being associated with children's expectancies (Chandler et al., 1980), or (3) an interaction of both, with fewer mother-reported stressors and greater father internality correlated with daughters', but not sons', internality (Tully et al., 2016).

Morton (1997) offered a possible explanation for the failure of cross-sectional studies to find a significant, reliable association between parent and child LOC based on his observation that the Rotter I-E scale was used in these studies to measure parents' LOC. Because the Rotter scale measures generalized (global) expectancies, he reasoned that a more specific scale focused uniquely on measuring parenting behavior expectancies might be more successful in tying parent LOC to child LOC. Campis et al. (1986) constructed a specific parenting LOC measure. Researchers using the scale have shown parent externality to be associated with a variety of negative children's outcomes (e.g., Mouton and Tuma, 1988; Roberts et al., 1992). But when Morton used the specific parenting LOC test, as well as the Rotter scale, he found no association with children's LOC as measured

by the Multidimensional Measure of Children's Perception of Control (Connell, 1985). Since no other study has used a specific parenting LOC scale and a LOC scale for children, the question of whether an association exists remains unanswered.

The lack of support for an association between parent and child LOC must be taken cautiously because most studies on this topic are limited by small sample sizes of homogeneous participants, cross-sectional designs which often excluded fathers (for exceptions, see; Ollendick, 1979; Chandler et al., 1980; Tully et al., 2016), and the administration of different locus of control tests to parents and children (with the exception of Ollendick and Tully et al.'s studies, which used parent and child forms of the Nowicki Strickland Internal External Control Scale). A more definitive answer may be found in data gathered from longitudinal studies that include a large representative population of participants and use parent and child LOC scales consistent with Rotter's definition. Fortunately, two large scale longitudinal studies meet these criteria: Schneewind (1997) in Germany and Nowicki et al. (2018a) in England.

Schneewind's study covered a time span of 16 years and included samples of mother-father-child triads from six different West German states (Schneewind et al., 1983). Children and their parents completed German translations of the Nowicki Strickland scales (Nowicki and Strickland, 1973; Nowicki and Duke, 1974) when the children were 12 (n = 285) and again 16 years later (n = 98). His prediction that children would model their parents' locus of control was only supported at the later testing time and only for fathers and daughters.

Nowicki et al. (2018a) longitudinal study included an even larger and more representative population (n = 6,123). They analyzed data from the responses of over six thousand parents (fathers and mothers) and their children to Anglicized versions of the Adult and Child Nowicki Strickland Internal External Control Scales. The participants were part of *A Longitudinal Study of Parents and Children* (ALSPAC, Golding, 2004), an ongoing longitudinal study begun in 1991 in the city of Bristol and its environs. One unique aspect of the data set was that parents completed LOC tests *prenatally*, as well as when their children were ages 6 and 16. The children's LOC scores also were gathered at ages 6 and 16. The findings provided some support for the modeling prediction; mothers' and fathers' prenatal LOC scores were related positively to those of their children's at ages 6 and 16. Of note, no significant gender or parent differences were found among the correlations.

Thus, based on the findings from two longitudinal studies, it appears parent and child LOC may be positively associated, particularly between fathers and daughters, in young adulthood. However, the relatively modest size of the correlations means there are still additional antecedent factors to be identified besides parental LOC.

Parental Involvement/Education/Home Life and Locus of Control

Types of parenting behaviors and the home life activities of children are considered next as possible antecedents. Nowicki et al. (2018b) investigated data gathered from mothers' (n = 6,381) observations of their home environment and their children that were made before the child's fifth birthday from within three areas: home environmental experiences, parenting, and dietary practices. For each area correlations were computed between the items completed by mothers and their children's LOC at 6 years of age. The identified significant variables (n = 31) were subjected to stepwise logistic regression analysis that led to the final model of predictors (n = 13) of externality of children at age 6.

Support was found for the general idea that a *lack* of a warm, nurturing environment (as indicated by less breastfeeding, less cuddling at night, and less frequently being read stories) was associated with children's externality. Children's externality also was associated with indicators of a lack of positive parental interest in the child, as reflected by mothers of external children being more likely to have television on all day long, more frequently slapping their children, and more likely viewing pets as equally important members of the family as children.

Furthermore, children's externality was associated with more parental attention to washing hands before eating and a greater likelihood of children eating a diet of processed food. These findings may suggest parents of externals are more attentive to the physical, rather than emotional, needs of the child; an idea that requires exploration in future research.

Another important aspect of parental involvement is the degree to which parents may "enable" their children. Lynch et al. (2002) found too much or too little parental involvement was associated with children's externality. Too much involvement, to the extent parents actually control most outcomes for their children, may teach children outcomes are not the result of their own behavior but, rather, due to the efforts of others. Too little involvement, perhaps to a neglectful degree, may deprive children of the support they need to examine behavior-outcome sequences and learn how to cope with failure, both basic to learning appropriate internality. These findings are consistent with those described earlier involving parenting styles.

One reason why parents may differ in how they treat their children is the amount of education they have obtained. Furnham and Cheng (2016) reviewed the relevant literature and determined a correlation exists between higher levels of parent education and greater internality in children. Their conclusion is supported by a more recent, large-scale prospective study (Golding et al., 2017). The authors suggested more educated parents may produce a greater number of stable organized learning experiences for their children compared to those offered by their less educated peers.

The identification of parenting behaviors associated with children's LOC also has been gathered from studies in which parent-child interactions were observed directly. Carton et al. (1996) predicted that parents of children with internal control expectancies would provide more contingent reinforcement, support, and encouragement of autonomy than parents of children with external control expectancies. In their study, mothers and their second-grade children were videotaped while interacting on a series of puzzles,

including a difficult one that elicited maternal involvement. The results indicated that, for boys, those with internal control expectancies had mothers who offered more contingent support (e.g., suggestions for how their children might solve the difficult puzzle), but were less likely to intrude or take over the puzzle for them. In contrast, boys with external control expectancies were more likely to have mothers who contingently ignored their struggles and/or intervened by completing the puzzles for them. These findings are consistent with those reported earlier indicating an association between lack of parental emotional support and children's externality (Nowicki et al., 2018b).

Carton and Nowicki (1996) conducted another observational study examining parenting behaviors and home environment for LOC development in children. The authors videotaped 7- and 8-year old children and their mothers' interactions while the children worked on several tasks. They also asked mothers to complete measures of their general home environment and stressful life events. Analyses revealed that, compared to children with external control expectancies, those with internal expectancies experienced fewer stressful events, less maternal control, and more maternal warmth.

In a third observational study of elementary aged children, Carton and Carton (1998) found greater maternal warmth, as defined by mothers' nonverbal behaviors (e.g., frequency of smiles, positive touches, and time gazing) was associated with children's internality. Consistent with this finding, Enger et al. (1994) found that, the higher the internality, the greater likelihood children had of receiving positive parental responses, but in this study in the form of *verbal* communication. Thus, internal LOC expectancies appear to be associated with parental warmth, whether communicated nonverbally or verbally.

The results of several studies suggest that stressful childhood environments may be associated with children's externality. The findings are consistent with Rotter's assumptions and with Bryant and Trockel (1976) explanation of how different kinds of stressful environments may affect LOC development. As the latter noted, "...to the extent that individuals particularly try to make sense of their stressful or perceived unusual life experiences, it is conceivable that variables such as critical stressful life events are also related to one's (external) locus of control orientation" (Bryant and Trockel, 1976, p. 266). Particular stressors already linked to children's externality include situations where children grow up with parental alcoholism (Post and Robinson, 1998), excessive physical punishment (Khayyer, 2003), psychiatric difficulties (Yates et al., 1994), maltreatment (Roazzi et al., 2016), intellectual deficits (Clark et al., 2004), or physical disorders such as Cerebral Palsy (Cohen et al., 2008).

In summary, support exists for an association between internality and greater parental education, warmth, support, and encouragement of autonomy based on findings from cross-sectional and longitudinal studies; a conclusion consistent with the one offered by Carton and Nowicki, 1994 in their review. However, since their review, results from studies in non-Western countries and certain ethnic groups within Western cultures suggest the antecedent-LOC relation may be more complex than previously thought. For example, there may be cultural differences in how support is demonstrated by parents and valued by children. We note that Rotter's original formula for predicting behavior includes reinforcement value and situational factors, as well as expectancies. It would seem logical that those additional constructs might be applicable when investigating the development of control expectancies and, to the best of our knowledge, few if any studies on antecedents have included them.

RECOMMENDATIONS FOR FUTURE RESEARCH

Self-Report vs. Observational Designs

Although Carton and Nowicki's original 1994 critical review called for more studies using observational methodologies to investigate the development of control expectancies, most researchers continue to rely primarily upon self-report approaches. While self-report data are relatively easier to obtain than those acquired through other methodologies, their scientific usefulness is limited for several reasons. First, self-report methodologies involving adult participants reflecting on parenting they received years ago as young children are problematic because respondents' memories may not be accurate. Second, self-report surveys often fail to ask about specific contingent parenting behaviors, making it difficult to accurately evaluate the results vis-a-vis Rotter's predictions about expectancy development.

Carton and Nowicki (1994) suggested two ways of reducing the potential bias in self-report methodology: (1) sampling younger participants and/or (2) asking parents to answer information about their own parenting behaviors. Both suggestions were applied in some studies, providing important corroborating evidence for predictions based on Rotter's theory (e.g., Keshavarz et al., 2013; Ahlin and Lobo Antunes, 2015; Tully et al., 2016; Nowicki et al., 2018a).

Only three studies have utilized observational methodologies to investigate parenting behaviors and children's locus of control orientation since Carton and Nowicki's review (Carton and Nowicki, 1996; Carton et al., 1996; Carton and Carton, 1998). The results of all three provided evidence that largely corroborated self-report data and supported predictions based on Rotter's theory. An advantage of such studies is that they provide specific behavioral exemplars for parents interested in promoting the growth of appropriate internal LOC expectancies in their children.

Consistency vs. Contingency

Besides noting methodological shortcomings, Carton and Nowicki called for greater awareness of what Rotter meant by "contingency learning" and how it differs from the concept of consistency. Contingency refers to when the occurrence of one event is dependent on the prior occurrence of another event. A contingent consequence can be formulated as an "if-then" statement: If you achieve X, then Y will happen; if you do not

achieve X, then Y will not happen. In the case of children's control expectancies, Rotter assumed parental reinforcement contingent on children's actions would be associated with the development of internal control expectancies. Conversely, consequences administered by parents that are not contingent on the children's behavior would be associated with the development of external control expectancies.

Note that consistency refers simply to the reliability of the behavior or outcome. A parent could consistently act in a non-contingent fashion toward their child, thus scoring high on consistency but low on contingency. In the only two studies on LOC antecedents that accurately measured parental contingent behaviors, results supported Rotter's presumed association between contingent outcomes and children's internality (Skinner, 1986; Carton et al., 1996).

Focus on Parents vs. Others

Most LOC antecedent studies have concentrated on parents and their children. Regrettably, little research has been done to evaluate the potential role of teachers or other significant adults outside of the home. This is true despite the fact that " children between the ages of five and eighteen spend most of their waking hours either in school or at home working on assignments given to them in school. American school children spend more time in school than do most other children in the world" (Nowicki, 2016, p. 89). Yet the possible effect of teachers, coaches, and other adults on control expectancies is largely unknown. Interestingly, some colleges now offer noncredit classes in which the goal is to teach students how their own behavior plays an important role in their personal and academic difficulties and successes based on the premise that LOC can be influenced by people other than parents (Downing and Brennan, 2019).

Gender Differences

Many of the antecedent studies have not systematically gathered information concerning how gender may affect the learning of internal and external control expectancies. In general, when scales constructed to be consistent with Rotter's definition are used, average scores for males and females do not differ (e.g.,Kulas, 1996; Wickline et al., 2011; Almajali, 2012). It is important to note that, although gender differences in LOC scores are infrequent, the predictive validity of LOC expectancies may differ by gender in some cases. One example is the prediction of academic achievement, where LOC more accurately predicts male, than female, performance outcomes (e. g., Kalechstein and Nowicki, 1997). Another example is from Schneewind (1997), in which father-daughter, but not father-son, LOC scores were significantly related, even though average LOC scores between sons and daughters did not differ.

While most studies have found LOC scores do not differ by gender, there are exceptions. For example, Gursoy and Bicakci (2007) found males to be more internal than females using a sample of Turkish lower socioeconomic children. Consistent with research noted earlier in this review regarding the potential mediating effects of cultural variables, the authors noted that Turkish females have more limited behavioral and social opportunities than males, which may impede their chances to learn from a wider range of behavioral contingencies.

Measuring Locus of Control as Defined by Rotter

When Rotter (1966) introduced LOC as a psychological construct, he also presented a self-report questionnaire constructed to be consistent with his definition; a questionnaire frequently used to assess adults' LOC since then. However, as time passed, the very popularity of the LOC concept created problems. As Nowicki and Duke (2016) concluded, "What once was a clearly defined global generalized expectancy construct that functioned as a major component of Rotter's social learning theory (1954), (LOC) appears to have morphed into a complex array of concepts that sometimes appear to be only tangentially related to the original LOC-R concept introduced by Rotter" (p. 150). Decades ago, Skinner (1996) found hundreds of definitions being offered for "locus of control" and a like number of tests being used to allegedly measure the construct. Unfortunately, some researchers failed to reference Rotter's social learning theory and the definition of LOC it offered. It should be noted that Rotter emphasized the concept of "expectancy" and gave it a major place in his theory, but often this concept and even the word "expectancy" are lacking in descriptions of many tests purporting to measure LOC or in studies with titles suggesting they are investigating LOC as defined by Rotter.

Skinner (1996) conclusion about the myriad of LOC definitions and scales remains relevant today: "Even a cursory consideration of the area reveals a large number of terms which, although different, nevertheless seem to be interrelated and partially overlapping" (p. 549). She went on to state that, "Within the total set of terms, some appear to be different labels for the same construct" and "probably most confusing are cases in which the same term is used to refer to different constructs" (p. 550). This jumble of terms and tests makes it difficult to generalize results across studies and to determine if the results are relevant to Rotter's theory.

To add to the confusion are the many content specific LOC tests, such as academic achievement (Crandall et al., 1965), health (Wallston et al., 1978), work (Spector, 1988), safety (Wuebker, 1986) and even God (Wallston et al., 1999), as well as tests attempting to assess different sources of externality (e. g., Levenson, 1975). Some of the tests have gathered considerable construct validity evidence, but many have not, and few have provided support of their test's "incremental" validity; that is, the ability of their specific LOC test to predict outcomes consistently and significantly better than generalized expectancy measures. Consequently, we do not know, for the most part, if specific content LOC expectancy tests are identifying new sources of variance or gathering the same information as the generalized LOC questionnaires.

To help clarify the measurement issues germane to the identification of developmental antecedents of LOC, we suggest the following. First, researchers use Rotter's definition of LOC as a generalized problem-solving expectancy. Second, they administer tests constructed to be consistent with Rotter's definition

accompanied by evidence of construct validity supporting their effectiveness. Third, investigators should note when they are departing from Rotter's definition and the tests constructed to be consistent with it. Fourth, when introducing tests of "locus of control" researchers include information showing how they are related to generalized LOC measures, evidence of their incremental validity, and findings supportive of the tests' use with the study population. With such information, researchers can more accurately distinguish evidence of antecedents for Rotter's defined LOC construct from other constructs.

CONCLUSION

We acknowledge the majority of our findings are based on data from Western English speaking populations and further studies need to be completed to determine their broader external validity. It also is important to note that childhood is not the only time-period in which LOC expectancies can be modified. Rotter (1954, 1966) social learning theory and subsequent empirical data indicate that certain salient events can modify LOC at other points in development (e.g., Nowicki et al., 2018a,c). That being said, Rotter's theory suggests that childhood is when the largest changes tend to occur in the development of generalized expectancies.

While studies showing the importance of the LOC construct as defined by Rotter (1966) continue to be published at an impressively high rate, research focused on identifying antecedents of internal and external generalized expectancies lags far behind. The results of the present qualitative review are somewhat consistent with those of Carton and Nowicki (1994). Parenting that allows children the freedom to experience the outcomes of their behavior, accompanied by the communication of warmth, support, and feedback when children fail, continues to be critical in the development of appropriate internality. However, researchers have not yet investigated the possible impact on children's LOC of other significant adults in children's lives, such as teachers and coaches.

Identifying relevant antecedents of LOC requires the use of appropriate tests and the application of Rotter's LOC definition and social learning theory. It is more obvious now than it was at the time of Carton and Nowicki (1994) review that confusion exists about what is being called "locus of control" and how it is being measured. We urge researchers to be clear in describing the LOC test they use and the LOC definition they apply.

We hope that raising awareness of LOC and summarizing the existing antecedent research will lead to more focused investigations of this important topic. LOC is one of the most researched and highly cited constructs in the history of psychology, in part because it has been shown to be a significant predictor of a diverse range of outcomes. If confirmed by results of studies from various cultures, the trend toward greater externality is troubling. As Rotter (1971) warned so many years ago in words that may be appropriate today: "*Our society has so many critical problems that it desperately needs as many active, participating internal-minded members as possible. If feelings of external control, alienation and powerlessness continue to grow, we may be heading for a society of dropouts – each person sitting back, watching the world go by" (p. 59).*

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Locus of Control and Negative Cognitive Styles in Adolescence as Risk Factors for Depression Onset in Young Adulthood: Findings From a Prospective Birth Cohort Study

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Whilst previous observational studies have linked negative thought processes such as an external locus of control and holding negative cognitive styles with depression, the directionality of these associations and the potential role that these factors play in the transition to adulthood and parenthood has not yet been investigated. This study examined the association between locus of control and negative cognitive styles in adolescence and probable depression in young adulthood and whether parenthood moderated these associations. Using a UK prospective population-based birth cohort study: the Avon Longitudinal Study of Parents and Children (ALSPAC), we examined the association between external locus of control and negative cognitive styles in adolescence with odds of depression in 4,301 young adults using logistic regression models unadjusted and adjusted for potential confounding factors. Interaction terms were employed to examine whether parenthood (i.e., having become a parent or not) moderated these associations. Over 20% of young adults in our sample were at or above the clinical threshold indicating probable depression. For each standard deviation (SD) increase in external locus of control in adolescence, there was a 19% (95% CI: 8–32%) higher odds of having probable depression in young adulthood, after adjusting for various confounding factors including baseline mood and different demographic and life events variables. Similarly, for each SD increase in negative cognitive styles in adolescence, there was a 29% (95% CI: 16–44%) higher odds of having probable depression in the adjusted model. We found little evidence that parenthood status moderated the relationship between external locus of control or negative cognitive styles in adolescence and probable depression following

adjustment for confounding factors. Effect estimates were comparable when performed in the complete case dataset. These findings suggest that having an external locus of control and holding negative cognitive styles in mid- to late adolescence is associated with an increased likelihood of probable depression in young adulthood.

Keywords: Avon Longitudinal Study of Parent and Children (ALSPAC), locus of control, negative cognitive styles, parenthood, young adulthood, depression, cohort study

INTRODUCTION

Depression is among the most common mental health disorders, with a lifetime prevalence ranging from 10 to 20% worldwide (Kessler et al., 2005; Lim et al., 2018). The substantial personal and societal costs associated with depression make it the third largest global contributor to Years Lost due to Disability (YLD) in women and fifth largest contributor to YLD in men (James et al., 2018). The effects of depression may be especially detrimental when occurring during pregnancy and in the post-partum period because of the potential impact on the fetus and child (Bauer et al., 2014; Gelaye et al., 2016; Rebecca M Pearson et al., 2018) [e.g., through the impact of depression on parenting practices (Lovejoy et al., 2000; Wyatt Kaminski et al., 2008; Wilson and Durbin, 2010)], and on the parent [e.g., it is the leading cause of mortality in high income countries due to suicide (Johannsen et al., 2016)]. In addition to the potential impact of maternal depression on child outcomes, growing evidence supports the role of common risk factors in the development of ante- and post-partum depression for both women and men along with the detrimental consequences that these mood disruptions have on later parenting practices and on child well-being (Ramchandani and Psychogiou, 2009; Gutierrez-Galve et al., 2019; Kiviruusu et al., 2020).

Identifying modifiable risk factors in adolescence which may influence depression onset in early adulthood could assist in the development of preventative strategies to reduce depression risk. Further, understanding the moderating role of parental status in this association could help tailor specific interventions targeting this possibly higher-risk group. Whilst extensive research has been devoted to the identification of risk factors for depression across different phases of life (Cole and Dendukuri, 2003; Al-Modallal et al., 2008; Leigh and Milgrom, 2008; Lemstra et al., 2008; Côté et al., 2009; Ripke et al., 2013; Biaggi et al., 2016; Khazanov and Ruscio, 2016; Köhler et al., 2018), few studies have investigated the role of risk factors for depression during an important transition of life, such as from adolescence into young adulthood or during the transition to parenthood (Schwartz et al., 2005; Ghosh, 2017; Sawyer et al., 2018; Kathryn, 2019).

Cognitive and personality theories of depression (Abramson et al., 1997; Rubenstein et al., 2016) suggest that variation in beliefs about the world and how an individual interprets negative events around them are key factors underlying vulnerability to depression. One important aspect in an individual's outlook is a concept termed locus of control (LOC). Rotter (Rotter, 1966) first defined locus of control as "…the degree to which persons expect that a reinforcement or an outcome of their behavior is contingent on their own behavior or personal characteristics vs. the degree to which persons expect that the reinforcement or outcome is a function of chance, luck, or fate, is under the control of powerful others, or is simply unpredictable." Attributing life events to external factors such as fate, luck, other people's power and/or considering them as unpredictable (i.e., external locus of control) has been found to be a risk factor for several adverse outcomes such as lower educational attainment (Golding et al., 2019), substance misuse (Lassi et al., 2019), chronicity of depression (Wiersma et al., 2011), non-suicidal and suicidal behaviors and ideation (Wester et al., 2016; Crandall et al., 2018), psychotic experiences (Thompson et al., 2011; Sullivan et al., 2017) and prenatal depression (Dimitrovsky et al., 1987; Richardson et al., 2012). Conversely, holding more internal locus of control beliefs has been associated with greater academic achievement (Findley and Cooper, 1983) and more positive work related feelings (Ng et al., 2006), sense of happiness (Pannells and Claxton, 2008) and lower depression (Crandall et al., 2018). However, without prospectively collected measures, these associations may be the result of reverse causation, namely depression could be causing the individual to have an external locus of control and negative cognitive styles and not vice-versa. Furthermore, residual confounding (i.e., due to unmeasured or imprecisely measured confounders) may still bias these estimates. For example, residual confounding could lead to an inflated estimate of the association due to unmeasured common causes of both our exposures and depression (e.g., if attachment insecurity caused both an external LOC and NCS and increased risk of depression).

"Negative cognitive styles" (Alloy et al., 1988) is an umbrella term that describes an individual's tendency to interpret causes of negative events as internal, global, and stable. These cognitive attributions are usually referred in the psychological literature as Negative Cognitive Schemas or Negative Cognitive Styles (NCS), as defined in Abramson's "hopelessness theory of depression" (Alloy et al., 1988). For example, after a confrontational discussion with one's partner, an individual holding NCS would attribute the cause of the negative event (i.e. the confrontational discussion) to his or her own bad character (internal), which will affect other aspects of his or her life (global), and will continue to negatively influence his or her life (stable). NCS have been associated with different negative outcomes such as depression (Nolen-Hoeksema et al., 1986; Sweeney et al., 1986; Abramson et al., 1989, 1997; Liu et al., 2015), suicidal ideation (Alloy et al., 2000) and more scholastic achievement related problems (Nolen-Hoeksema et al., 1986).

There is already evidence linking external LOC and NCS to depression (Benassi et al., 1988; Ross and Mirowsky, 1989; Kelvin et al., 1999; Evans et al., 2005; Richardson et al., 2012). Meta-analyses of observational studies found evidence for an association of LOC (Cheng et al., 2013) and NCS (Sweeney et al., 1986; Hong and Cheung, 2014) with depression. However, most studies included in these meta-analyses were cross-sectional making the potential direction of the association between LOC and depression unclear. Several theories suggest different directions of association. External LOC and NCS could be the result of current states of depression ("state hypothesis") or a consequence of previous depression ("scar hypothesis") (Lewinsohn et al., 1981). In support of both state and scar models, small experimental studies provide evidence that experimental manipulation of mood results in distorted cognitions (Kelvin et al., 1999) and that activation of depressed memories reduces perceived control (Obhi et al., 2013); similarly, the seminal work of Seligman on dogs demonstrated that induced lack of control led to learned helplessness, which shares various features with reactive depression (Seligman, 1972). Alternatively, NCS and LOC may represent a causal vulnerability factor for future depression as hypothesized in the vulnerability theory of depression (Barnett and Gotlib, 1988; Abramson et al., 1989). Evidence from longitudinal studies have also highlighted the role of NCS as a risk factor for future depression independently from baseline levels of depression (Nolen-Hoeksema et al., 1986; Alloy et al., 2000; Evans et al., 2005; Pearson et al., 2015) therefore representing a vulnerability factor beyond current state of depression. However, these studies only adjusted for concurrent depression and they did not investigate whether NCS could have been explained by past depression ("scar hypothesis"), leaving the question of whether these constructs have arisen in response to previous depressive symptoms unanswered. Understanding the direction of the relationship is important because NCS and LOC would only be suitable as potential prevention targets for depression if these factors lead to later depression.

Investigating how these psychological constructs (i.e., LOC and NCS) relate to onset of depression could be especially important because they are relatively stable across time (Dozois, 2007; Hankin, 2008; Elkins et al., 2017; Nowicki et al., 2018), can be modified, and effective interventions that target them are already available [e.g., cognitive behavioral therapy (CBT)] (Simmons and Parsons, 1983; Sharp et al., 1997; Osamuyi, 2000; Dozois and Quilty, 2013). Assessing the potential causal role of such constructs in adolescence may lead to implementation of these interventions at a preventive level at this developmental stage (Mehrtak et al., 2017). Moreover, understanding the role of thinking styles (locus of control and negative cognitive styles) in depression onset may help in the early identification of at-risk populations.

The Present Study

The current study, based on participants from a large contemporary UK cohort, examined the association between both external LOC and NCS and depression in young adults and explored whether these associations were moderated by parenthood. We estimated the magnitude of these associations whilst adjusting for the effects of confounding variables related to baseline (i.e., concurrent mood) or previous mood and various socio-demographic factors and life events.

By using longitudinal data from ALSPAC, we can disentangle whether our identified risk factors are implicated in depression onset or are merely early manifestations of underlying depressive symptomatology and/or the consequences of common causes of LOC and NCS and depression. In addition, we can compare these relationships in parents and non-parents from the same original sample.

This study aimed to answer two main questions:

1. Are LOC and NCS associated with depression onset in young adults, independently from various confounding factors?
2. Does being a parent moderate the relationship between both LOC and NCS in adolescence and depression in young adulthood?

MATERIALS AND METHODS

Participants

This study used data obtained from participants of the Avon Longitudinal Study of Parents and Children (ALSPAC), also known as Children of the 90s, which is an ongoing prospective population-based birth cohort study. The aim of ALSPAC is to investigate genetic and environmental determinants of health; for this reason, several biological, geographical, environmental, psychological and other variables were collected, including the child LOC, NCS and depressive symptoms which are used in our analyses (Golding, 2004; Boyd et al., 2013; Fraser et al., 2013). Between 1990 and 1992, all pregnant women residing in Bristol and the surrounding area, previously known as Avon county, were invited to take part in ALSPAC. 14,541 pregnant women were recruited. The original mothers and partners [Generation 0: ALSPAC-G0 (Fraser et al., 2013)], and their living children [Generation 1: ALSPAC-G1 (Boyd et al., 2013)], have been followed-up regularly since recruitment through questionnaires and clinic assessments. Complete details of the data and other information are available online and can been found at the following address (www.bris.ac.uk/alspac), and the ALSPAC data dictionary can be found at (www.bris.ac.uk/alspac/researchers/data-access/data-dictionary). Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and South West National Health Service (NHS) Research Ethics Committee; participants gave written informed data consent.

The present study is based on ALSPAC-G1 participants who had information available on parenthood status and who had completed a self-report questionnaire on depression at 23 years of age (Short Mood and Feelings Questionnaire; $N = 4{,}022$) or, alternatively, who had completed the same self-report questionnaire at 21 or 22 years of age (whose information were used to impute the main outcome). Participants and researchers involved in assessments were unaware of specific hypotheses or any results of previous assessments.

A flow chart describes ALSPAC-G1 participants included in this analysis (**Figure 1**). Sample characteristics of those

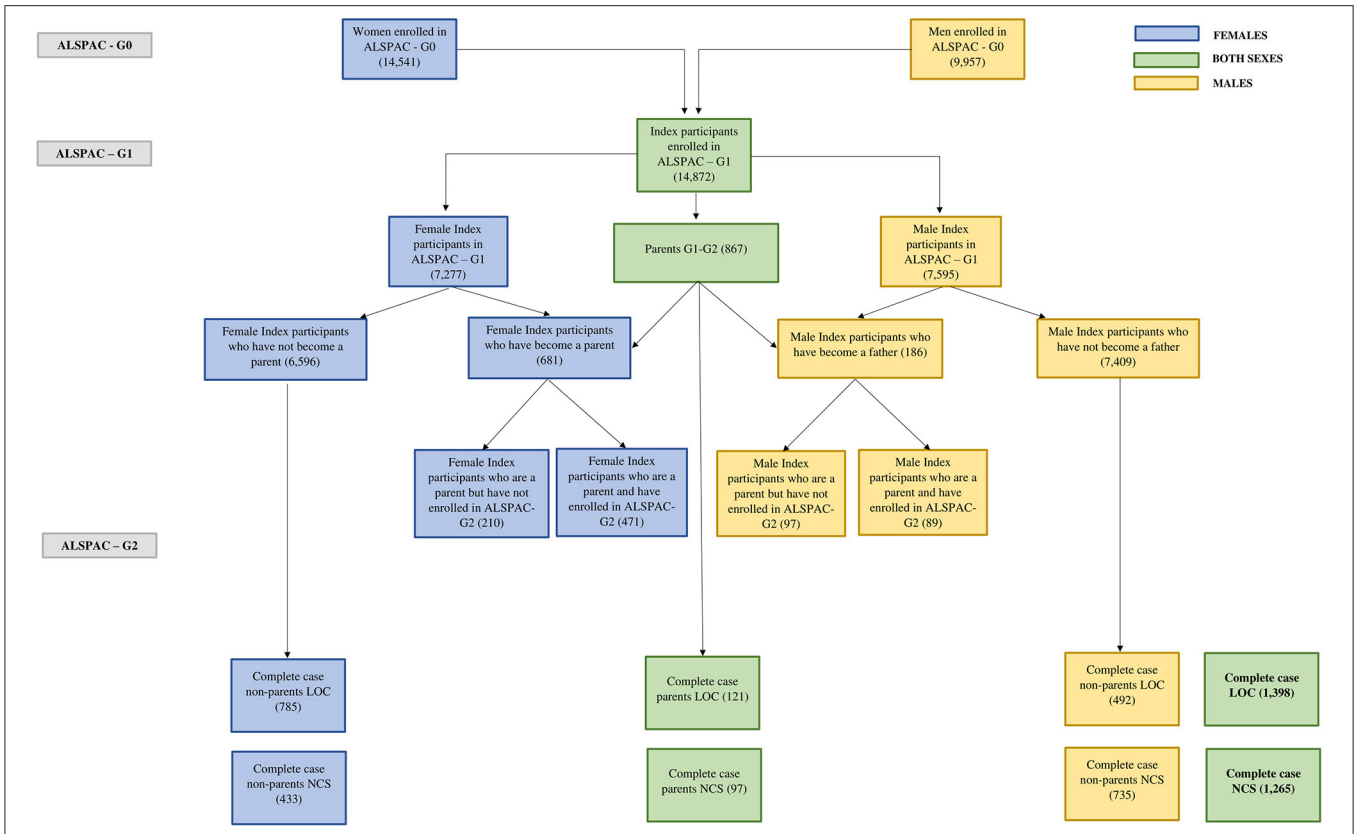

FIGURE 1 | ALSPAC Flow. The present figure illustrates the sample included in our analyses (bottom rows of the graph) for both the LOC and NCS models. It describes the flow from the original mothers (ALSPAC-G0) recruited in the study up to the participants who had all the information needed to be eligible for our analysis. In the center of the figure we also illustrate how many ALSPAC-G1 participants are known to have become parents and how many have enrolled their children into the next ALSPAC generation (ALSPAC-G2). Different colors are used to distinguish between males and females. The legend of the colors is embedded in the figure.

who contributed to the analyses and of those who did not because of missing data or loss to follow-up are reported in **Supplementary Table 1**.

Measures

Exposure Measures: LOC and NCS

The psychological risk factors considered in G1 children/adolescents were as follows:

- LOC was assessed with the shortened version of the Children's Nowicki-Strickland Internal-External scale (CNSIE) (Nowicki and Strickland, 1973) (N = 5,101). A paper version of the questionnaire was sent to the homes of participants as part of the 198-month assessment. The mean age at completion of the LOC measure was at approximately 16 years and 2 months. A total score was derived by the sum of each item response with a higher score representing a more external style (**Supplementary Table 2** for items). CNSIE showed a Cronbach's α of 0.57, which indicates levels of internal consistency that are slightly below satisfactory (i.e., Cronbach's $\alpha > 0.60$). However, this measure has been used in previous research research using the same sample as our analysis (Culpin et al., 2015) and does not largely deviate from the estimates presented by Nowicki (2018) who reported internal consistency estimates ranging from 0.60 to 0.70 for locus of control as measured with the CNSIE. Analyses were performed using the continuous and standardized z-score.
- NCS was assessed with the Cognitive Style Questionnaire Short Form (CSQ-SF) (Meins et al., 2012), which was administered to the ALSPAC index child (N = 4,171) by an interviewer who collected the responses on paper at the Fourth Teen Focus research clinic when participants were an average age of 17 years and 10 months. The questionnaire presents different hypothetical scenarios and asks the participant to imagine those scenarios happening to them and to rate their reactions to those situations (**Supplementary Table 3** for items). Four possible patterns of causal attributions are derived (internal, stable, global, self-worth). Possible total scores range from 64 to 320, with higher scores indicating a more negative cognitive style. The total score for CSQ-SF demonstrated a good internal consistency, with a Cronbach's α of 0.88. Analyses were performed using standardized total z-score after median imputation.

Outcome Measure: Probable Depression Diagnosis

The short mood and feelings questionnaire (SMFQ) (Ancold and Stephen, 1995; Turner et al., 2014) was used to measure

depressive symptoms in ALSPAC-G1 participants ($N = 4{,}022$). The SMFQ is a 13-item questionnaire that measures depressive symptomatology over the preceding 2 weeks with higher scores indicating more severe depressive symptoms (range 0–26) (**Supplementary Table 4** for items). The SMFQ demonstrated good discriminatory abilities for identification of depression as measured by Computerized Interview Schedule-Revised (CIS-R) which uses ICD−10 diagnostic criteria (area under ROC curve = 0.90) (Turner et al., 2014). The SMFQ was administered when the participants were approximately 23 years of age [mean age of SMFQ completion = 23.9 years old (SD = 0.5)]. The questionnaire was available to complete in either online or paper format; responses to the online questionnaires were collected and managed using REDCap electronic data capture tools (Harris et al., 2009) hosted at the University of Bristol. £10 shopping vouchers were sent to all the participants who took part in the study. High levels of depression were defined by a score of 11 or higher according to commonly used clinical thresholds (Turner et al., 2014; Kwong et al., 2019). In this study, analysis of the internal consistency of the SMFQ using Cronbach's α showed good levels of inter-item reliability ($\alpha = 0.91$). The SMFQ was used to assess depression symptomatology in all ALSPAC-G1 participants (regardless of their parental status). However, because of the availability of questions on parental status, we were able to discern levels of depression in participants who had become parents. Participants who had become parents or expectant parents after the SMFQ assessment were not included in the analyses.

Moderating Variable: Parental Status

The variable indicating parental status was built including all ALSPAC participants who were known to have become parents or were expecting a child at the time of the assessment of the outcome (SMFQ at 23 years of age) ($N = 790$). This information was either obtained by including all participants who enrolled as parents of the second generation of ALSPAC (ALSPAC-G2) (Lawlor et al., 2019) or by including those ALSPAC participants who had responded affirmatively (i.e., they have a child) to at least one of the repeated questions about parenting (from age 16 to 24). The questions that have been used to identify parents are reported in the **Supplementary Table 5**.

Confounding Factors

Being more externally oriented or holding negative cognitive styles whilst reflecting upon negative causes of events may be the result of an underlying depressive disorder, which is also a cause of future depression, and thus could act as a confounding variable. Therefore, we adjusted for baseline (concurrent) mood both in the LOC and NCS models. Additionally, as a sensitivity analysis we adjusted for depression symptoms measured in the previous visit instead of the concurrent visit (in separate models for LOC and NCS and using a measure of depressive symptoms at 13 and 16 years of age, respectively). Adjustment for depression during the previous visit was performed because a prior experience of depression could have still acted as a common cause of both LOC and NCS and subsequent depression even if depression symptomatology was absent at the moment in which LOC and NCS were assessed ("scar hypothesis"). Other confounding factors adjusted in the models were: anxiety symptoms, sex (males vs. females) (Dekker et al., 2007; Sterba et al., 2007; Kuehner, 2017), variables related to socio-economic positions (i.e., maternal education and occupational social class) (Stoolmiller et al., 2005; Costello et al., 2008), adverse experiences during childhood (e.g., physical, sexual abuse, bullying and parental separation) (Stoolmiller et al., 2005; Singham et al., 2017), lower cognitive abilities (Petersen et al., 1993) and maternal depression (Petersen et al., 1993; Rebecca M Pearson et al., 2013) (**Figure 2**). A complete list of covariate variables that have been used is provided in **Supplementary Table 6**.

Statistical Analyses

All analyses were performed with Stata (version 15.1). We employed unadjusted and adjusted logistic regressions to examine the associations between both LOC and NCS and depression. Primary analyses were conducted on the imputed datasets. To address the first question of this study (i.e.., "are LOC and NCS associated with later probable depression independently of known confounding factors?") we employed multivariable logistic regression with continuous risk factors (i.e., LOC and NCS) which were standardized to create Z scores with a mean of 0 and a SD of 1 adjusted for the above-mentioned list of confounding factors. We used commonly used thresholds to define elevated probable depression which have been validated against ICD-10 depression via clinical interviews. Odds Ratios (OR) are presented in order to clearly illustrate how our risk factors are associated with clinically relevant depressive symptoms. Moreover, by using logistic models we overcome the non-normal distribution of the continuous outcome which has a skewed distribution in this sample (Kwong, 2019). Analyses were stratified by sex to investigate the strength of these associations in males and females. This was conducted because there are higher rates of depression in females than males (Kuehner, 2017). To address the second question of this study (i.e., "Does being a parent moderate the relationship between both LOC and NCS in adolescence and depression in young adulthood?"), moderation analyses where conducted to explore a potential interaction between parental status and our exposures (i.e., LOC and NCS) for depression at 23 years, given a slightly higher prevalence of depression in parents compared to non-parents in our sample.

95% Confidence Intervals (CIs) were reported for all analyses. Distributions of demographic and psychological risk factors across the two groups (parents and non-parents) were compared through chi-squared tests (categorical variables) and Welch un-paired *t*-tests (continuous variables) (Delacre et al., 2017). We also present analyses on those with no missing data (known as complete case analyses) in the **Supplementary Materials**.

Missing Data

Sample attrition led to a substantial amount of missing data, particularly for the outcome and the confounders. After analyzing proportions of missingness according to different socio-demographic indicators and exploring variables associated to missingness (**Supplementary Tables 7** and **8**) we performed

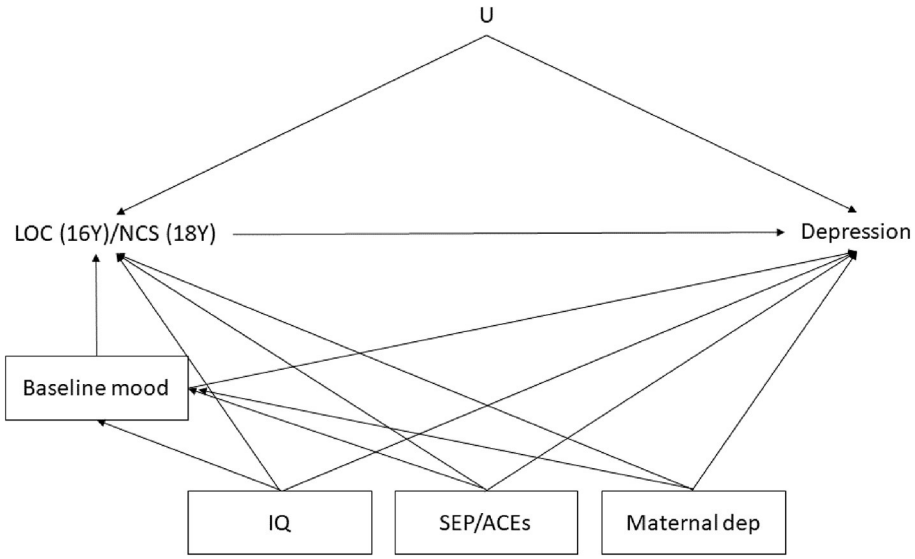

FIGURE 2 | Directed Acyclic Graph (DAG) representing hypothesized causal relationship between our exposures (locus of control and negative cognitive styles) and our outcome (depression). "U" represents the unmeasured/unknown confounding factors which we cannot adjust for. In the Locus of control model, baseline depression and anxiety were measured with the SMFQ and the GAD subscale of DAWBA, respectively. In the Negative Cognitive Styles model, baseline depression and anxiety were measured with depression and anxiety subscale of CIS-R at 18 years old. Depression represents the outcomes which was measured with the SMFQ at 23 years of age. IQ was measured at 8 years old as a total score derived by the Wechsler Intelligence Scale for Children, Socio Economic Position related variables included: maternal education, maternal social class and a continuous score of the Adverse Childhood Experiences (ACE) variables, sex. "Maternal Dep" stands for the maternal (ALSPAC-G0) depression during pregnancy measured with the EPDS. Correlations between confounding factors are not represented for simplicity.

analysis under the assumption that data were missing at random (MAR). MAR refers to a type of missingness that can be explained by observed variables (e.g., socioeconomic status, previous measures of mental health). Since some of the variables that are associated with missingness (i.e., auxiliary variables in our imputation model) were not included as confounding factors, using the complete case dataset may provide biased estimates (Hughes et al., 2019). For these reasons, our primary analyses are performed in the multiply imputed datasets. Thanks to the wealth of auxiliary variables (i.e., variables associated with missingness and with the variables in the model) that we were able to include in our imputation model the imputed datasets should increase statistical power (Sterne et al., 2009; Hughes et al., 2019). As the underlying assumptions differ between complete case and multiple imputation analyses, consistent results with both methods increase confidence that they are not biased by missing data (Hughes et al., 2019). Multiple imputation through chained equations, also known as fully conditional specification, on 100 imputed datasets with 50 cycles of regression switching were performed separately for parents and non-parents (Tilling et al., 2016) using the ice command in Stata 15.1 (Royston, 2005, 2007; Sterne et al., 2009). We used predictive mean matching (STATA match command) to match the imputed exposures and outcome variables on the distribution of the complete case variables (Rubin, 1986). When imputing, we included all the variables of our models (including covariates) and auxiliary variables which were associated with the outcome (depression) and/or with the missingness (a list of variables used is presented in the **Supplementary Table 9**). Parents and non-parents imputed datasets were appended after imputations using the mi append, automatic command. Including auxiliary variables is recommended to make the MAR assumption more plausible (Hughes et al., 2019), however we kept the number of covariates included relatively small to avoid overfitting the models (Lee et al., 2020). Estimates from different imputed datasets were combined and analyzed using Rubin's rules (White et al., 2011). Monte Carlo errors were <10% of the standard error and fraction of missing information (FMI) values were no larger than 0.53, both indicating an adequate level of statistical reproducibility of the multiply imputed analyses (Madley-Dowd et al., 2019).

RESULTS

Demographic Differences Between Parents and Non-parents

Participants who had become parents and those who had not were compared on basic demographic and psychological variables using a Welch *t*-test where continuous and chi-squared test where categorical (**Table 1**). Parents differed from their peers who had not become parents on basic socio-demographic variables and on LOC at 8 and 16 years old. Those who had become parents generally came from poorer socio-economic backgrounds (e.g., lower parental education, lower parental social class and lower income) and were more externally oriented both at 8 and 16 years of age.

TABLE 1 | Demographic and psychological differences between ALPSAC-G1 parents (either those who enrolled and those who did not enroll in ALSPAC-G2) and non-parents.

Variables[a]	Sample						Test
	ALSPAC-G1 Non-parents			ALSPAC-G1 Parents			
	N	Mean (SD)	95% CI	*N*	Mean (SD)	95% CI	Welch *t*-test
G0 maternal weekly income during pregnancy	9,363	313.3 (139.4)	310.46–316.11	616	269.52 (124.04)	259.71–279.34	8.41
Age of menarche	3,666	12.64 (1.16)	12.61–12.68	479	12.49 (1.17)	12.39–12.59	2.65
Locus of control 8y	5,927	5.95 (2.08)	5.90–6.00	446	6.47 (2.01)	6.28–6.66	−5.25
Locus of control 16y	4,645	3.08 (2.08)	3.02–3.14	452	4.00 (2.28)	3.79–4.21)	−8.31
Cognitive styles 18y	3,822	161.76 (20.07)	161.12–162.40	349	161.12 (21.32)	158.88–163.37	0.54
	N	Frequencies %		*N*	Frequencies %		Chi^2
G0 maternal education							
Low (Lower than O level)	3,508	29.8		240	35.4		
Medium (O level)	4,050	34.4		267	39.4		32.07
High (A level or higher)	4,229	35.9		171	25.2		
G0 Paternal education							
Low (Lower than O level)	3,870	34.2		272	41.9		
Medium (O level)	2,399	21.2		152	23.4		25.67
High (A level or higher)	5,065	44.7		226	34.8		
G0 Maternal social class following Office of Population Censuses and Surveys (OPCS) codes							
Low	5,966	62.4		362	68.2		7.28
High	3,602	37.7		169	31.8		
G0 Paternal social class following (OPCS) codes							
Low	5,667	54.5		384	65.2		25.94
High	4,738	45.5		205	34.8		
G0 maternal depression							
No	9,871	86.3		539	84.2		2.12
Yes	1,572	13.7		101	15.8		

Legend: Age of menarche was measured as a derived variable where the first reported age at onset of menarche was used, Locus of control was measured at 8 and 16 years old with the CNSIE, negative cognitive styles was measured at 18 with the CSQ. Variables preceded by "G0" refer to measures which were captured in the parents of our target sample (i.e., ALSPAC-G1). Maternal and Paternal educational attainment was coded as 0 = A level or higher, 1 = O level, 2 = < O level, maternal and paternal social class was coded as 0 = high social class and 1 = low social class, G0 maternal depression refers to depression symptomatology of women during pregnancy as measured with the EPDS and dichotomised using a cut off of >12 to determine probable diagnosis of major depression.

Depression Levels

In the total sample, 994 (24.7%) out of 4,022 participants who completed the SMFQ at 23 years old scored at or above the clinical threshold for depression (cut-off of ≥11). When stratifying by sex, 723 (27.4%) females, and 269 males (19.5%) scored at or above the clinical threshold indicating probable depression. When stratifying by parenthood status, 851 (24.4%) non-parents and 141 (26.3%) parents scored at or above the clinical threshold for depression. Of these 851 non-parents, 248 (19.4%) were men, whereas 603 (27.4%) were women. Similarly, of the 141 parents who scored above the clinical cut-off for probable depression, 21 (20.6%) were men, whereas 120 (27.6%) were women.

Overall, depression levels were high in the complete sample irrespective of parenthood status. However, as expected, women had higher levels of depressions than men, regardless of parenthood status.

Comparison of Characteristics Between Samples With Missing and Non-missing Information

Analysis of the socio-demographic differences across various samples indicated that the participants with missing data comprised individuals who were more disadvantaged (i.e., had lower education and more socioeconomic disadvantage) compared to those who were not lost to attrition (**Supplementary Table 1**). Those with complete data were more likely to come from families of parents who were educated beyond secondary school (A level or higher) and of a higher socio-economic class (e.g., non-manual jobs), to have mothers who gave birth at a later age, and had mothers who were less likely to have smoked during the first trimester of pregnancy. However, the study sample also comprised a higher percentage of participants who reported physical or sexual abuse during childhood. There was evidence that participants with missing

data on depressive symptoms were more likely to have reported an external LOC at 16 years of age, had their mother reporting smoking during pregnancy, had a family which scored lower on various socioeconomic indicators and were more likely to have had a physical illness during their childhood.

Associations Between LOC and NCS in Adolescence With Probable Depression in Adulthood

There was evidence for an association between LOC at 16 years and depression at 23 years (**Table 2**). An increase of one standard deviation in LOC score at 16 years was associated with a 62% (CI: 49 to 76%) increase in odds of probable depression at 23 years. After adjusting for confounding variables there was a marked attenuation toward the null, although evidence for an association between LOC and depression remained (19%, CI: 8 to 32%). Similarly, we found evidence for an association between NCS at 18 years and probable depression at 23, with a 50% increase in odds of depression for every SD increase in NCS (CI: 37 to 65%). Once adjusted for potential confounding factors the association attenuated but remained consistent (29%, CI: 16 to 44%). In addition, when using previous depression measure instead of baseline depression the results did not markedly change both in the LOC model and in the NCS model.

Finally, in the analyses performed in the complete case dataset, effect estimates were comparable to those obtained in the imputed datasets (**Supplementary Tables 10–14**). However, as expected, confidence intervals in the imputed analyses were narrower, indicating higher statistical precision and power.

Parental Status as Weak Moderator of the Association Between LOC and NCS With Probable Depression

We stratified our analyses based on sex and on parenthood. Moreover, we explored whether there is an interaction between parenthood and both LOC and NCS, with depression as the outcome (**Table 3**). Stratification by sex did not show any strong differences in the associations between both LOC and NCS with depression in males and females (**Table 4**). However, when we stratified our analyses based on parental status, differences in effect estimates in parents and non-parents provided suggestive evidence for a possible moderating effect of parenthood. Thus, we investigated whether there was evidence for an interaction between parental status and both our exposures (i.e., LOC and NCS), with our outcome of interest (i.e., depression as measured by the SMFQ at 23 years). We found limited evidence for an interaction between parental status and our exposures for depression (OR: 1.10, CI: 0.94–1.30, OR: 1.14, CI: 1.00–1.29, respectively in LOC and NCS models) once adjusted for covariates.

DISCUSSION

The present study, based on a large prospective population-based cohort, provides further evidence for a prospective association between both LOC and NCS and probable diagnoses

TABLE 2 | Main analyses: unadjusted and adjusted logistic regressions of locus of control and negative cognitive styles on depression, in total sample and in parents in multiple imputed datasets.

Sample[1]	Locus of control						Negative cognitive styles					
	Unadjusted[a]			Adjusted[b]		Adjusted[c]	Unadjusted[a]			Adjusted[b]		Adjusted[c]
	N	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI) *P*-value	*N*	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI) *P*-value
Total sample[c]	4,301	1.62 (1.49–1.76)	<0.001	1.19 (1.08–1.32)	0.001	1.35 (1.23–1.49) <0.001	4,301	1.50 (1.37–1.65)	<0.001	1.29 (1.16–1.44)	<0.001	1.24 (1.11–1.39) <0.001
Parents	509	1.82 (1.43–2.22)	<0.001	1.50 (1.10–2.04)	0.01	1.59 (1.19–2.14) 0.002	509	1.56 (1.21–2.00)	0.001	1.36 (.99–1.85)	0.05	1.30 (.95–1.79) 0.10

[1] *OR, odds ratio; CI, Confidence Interval; SMFQ, Short Mood and Feeling Questionnaire.*

[a] *Univariable associations between standardized continuous score of LOC/NCS.*

[b] *Multivariable associations between standardized continuous score of LOC/NCS, confounding variables adjusted for: baseline/concurrent depression and anxiety, gender, maternal depression, maternal social class, maternal education, ACE classic total score, IQ at 8 years old.*

[c] *Multivariable regressions between standardized continuous score of LOC/NCS, confounding variables adjusted for: previous depression, anxiety, gender, maternal depression, maternal social class, maternal education, ACE classic total score, IQ at 8 years old.*

TABLE 3 | Unadjusted and adjusted odds ratio for adult depression according to continuous scores of locus of control and negative cognitive styles and stratified by parental status in multiple imputed datasets.

	Moderation model by parenthood							
	Entire sample (4,301)		Parents[a] (509)		Non-parents (3,792)		Interaction term	
	OR	95% CI, p	OR	95% CI, p	OR	95% CI, p	OR	95% CI, p
Locus of control	1.62	1.49–1.76, <0.001	1.82	1.43–2.22, <0.001	1.61	1.47–1.76, <0.001	1.10	0.95–1.28, 0.22
Locus of control adjusted for confounding factors[b]	1.19	1.08–1.32, 0.001	1.50	1.10–2.04, 0.01	1.17	1.06–1.31, 0.003	1.10	0.94–1.30, 0.23
Cognitive styles	1.50	1.37–1.65, <0.001	1.56	1.21–2.00, 0.001	1.49	1.35–1.65, <0.001	1.22	1.07–1.40, 0.004
Cognitive styles adjusted for confounding factors[b]	1.29	1.16–1.44, <0.001	1.36	.99–1.85, 0.05	1.29	1.15–1.44, <0.001	1.18	1.03–1.34, 0.01

Outcome: binary SMFQ at 23 years.

[a]*All ALSPAC-G1 participants who have become parents (regardless their enrolment in ALSPAC-G2).*

[b]*Multivariable regressions between standardized continuous score of LOC/NCS and depression, adjusted for the following confounding variables adjusted for: baseline depression and anxiety, gender, maternal depression, maternal social class, maternal education, ACE classic total score, IQ at 8 years old.*

TABLE 4 | Unadjusted and adjusted odds ratio for adult depression according to continuous scores of locus of control and negative cognitive styles and stratified by sex in multiple imputed datasets.

	Entire sample (4,301)		Male (1,541)		Female (2,760)	
	OR	95% CI, p	OR	95% CI, p	OR	95% CI, p
Locus of control	1.62	1.49–1.76, <0.001	1.53	1.31–1.79, <.001	1.62	1.47–1.78, <0.001
Locus of control adjusted for confounding factors[a]	1.19	1.08–1.32, 0.001	1.16	0.96–1.40, 0.13	1.21	1.07–1.36, 0.002
Cognitive styles	1.50	1.37–1.65, <0.001	1.44	1.22–1.71, <0.001	1.51	1.36–1.68, <0.001
Cognitive styles adjusted for confounding factors[a]	1.29	1.16–1.44, <0.001	1.27	1.05–1.53, 0.01	1.30	1.16–1.46, <0.001

Outcome: binary SMFQ at 23 years

[a]*Multivariable regressions between standardized continuous score of LOC/NCS and depression, adjusted for the following confounding variables adjusted for: baseline depression and anxiety, gender, maternal depression, maternal social class, maternal education, ACE classic total score, IQ at 8 years old.*

of depression in young adults. Moreover, this study provides the first evidence on whether parenthood has a moderating role on these associations. As expected, adolescents who reported having a more external LOC and had cognitive biases in the attribution of causality for negative events (i.e., they held global, stable and internal self-blaming beliefs about these events; NCS) were more likely to have higher levels of probable depression in young adulthood. Although the effect estimates of LOC and NCS on depression attenuated somewhat after adjusting for various confounding factors, there was still evidence to support their independent association with probable depression and, thus, sustaining the vulnerability theory (Abramson et al., 1999) compared to the "state" and "scar" hypothesis (Lewinsohn et al., 1981). In fact, by adjusting for depression and anxiety symptoms measured both prior to and at the time of the assessment of the exposure, we were able to exclude the possibility that all the observed association between LOC and NCS with later depression was driven from the current mood state ("state hypothesis") and previous mood ("scar hypothesis"). In addition, even small effect sizes of risk factors measured as continuous variables may have an important effect at the population level when the outcome studied is common. For example, if we assume that our findings are valid, a 1 SD increase in ELOC (adjusted model) would lead to a 4% higher absolute risk for probable depression in young adults (28 vs. 24%) given the relative risk of probable depression (OR=1.19 per SD increase in ELOC) and prevalence of this condition in our sample (24%). This would mean that, if our findings are generalisable to the geographical area surrounding Bristol (i.e., South West England), which has a population of 63,929 individuals who were 24 years of age (OfN, 2018), a 1 SD increase in ELOC during adolescence would translate to 2,915 more people at risk of probable depression (18,258 vs. 15,343 individuals). Similarly, a 1 SD increase in NCS (adjusted model) would lead to a 7% higher absolute risk for probable depression in young adults (31 vs. 24%) given the relative risk of probable depression (OR of 1.29 per SD increase in NCS). This would translate into an additional 4,475 more people at risk of probable depression (19,818 vs. 15, 343 individuals). These figures highlight the potential public health utility in targeting risk factors when the outcome of interest (i.e., depression) is common in the population.

One novel aspect of the current contribution is the age range that we have explored from mid- to late adolescence to early adulthood and the fact that we have explored the probability of depression in young adults who have become parents and in those who have not. If the relationship between external LOC/NCS and later depression was found to be causal (e.g., through a well-conducted randomized controlled trial), developing preventive interventions to enhance an internal sense of control and reduce automatic negative biases could lower individuals' risk of developing depressive symptomatology. For example, when negative events occur such an intervention could increase the level of resilience an individual holds, providing positive resources to young adults to use in the presence of changes (e.g., transition to adulthood or parenthood) and in the presence of adverse events (e.g., COVID-19 outbreak) (Ng-Knight and Schoon, 2017). Indeed, holding an internal sense of control may be a particularly important resource in the transition to adulthood, when important individuation processes (e.g., choosing a university, starting a job, moving out of one's parent's house, starting a family) are occurring (Mirowsky and Ross, 2007; Settersten, 2007; Surjadi et al., 2011). This may be especially true in individualistic societies where values like individual sense of agency and personal responsibilities are emphasized and therefore may not be generalisable to societies with different values systems (Cheng et al., 2013).

BOX 1 | Case example.

XXX is a 16-year-old student who is preparing for his General Certificate of Secondary Education (GCSE). He is experiencing a lot of anxiety and uncertainty about how the exams might go and he is having difficulties in concentrating. He took part in a Cognitive Behavioral Therapy course where his therapist identified a series of conditional beliefs: "Nothing I do can change how the exams will go, it is just a matter of luck!." He would often feel guilty and stressed about the upcoming exams and in study groups he would often lose focus while studying. In one mock exam offered by the school, he had forgotten to complete a math problem. He then thought "All my exams will go terribly" and "I am such an idiot and I can't learn anything" and his mood started to worsen. The therapist helped him in re-assessing the automatic thoughts that XXX had after that minor negative event, in turn helping him to reduce feelings of low self-worth and changing those generalized beliefs into more specific ones. Rather than thinking that passing the exams was a matter of luck, he was encouraged to feel more in control of behaviors that he could employ to improve his results (such as revising and asking teachers for help) and to realize exams are just one aspect of his life which helps him to not catastrophise from that single experience.

Is Being a Parent a Risk Factor?

One aim of this study was to explore whether becoming a parent moderated the association between LOC and NCS in adolescence and liability to depression in young adulthood. In this cohort, becoming a parent at a young age does not seem to represent a strong risk factor for depression development. Prevalence of depression is high in both groups (parents and non-parents) consistent with what has previously been reported in the literature (Evenson and Simon, 2005; Rimehaug and Wallander, 2010). In this study we have combined mothers and fathers into a single sample of parents because we lack statistical power to detect differential associations between our risk factors and our outcomes across groups stratified on both sex and parenthood status, given low numbers of fathers ($N = 19$ in the fully adjusted model). However, being a parent represents a shift from being largely only responsible for oneself to being responsible for dependents, independent of the sex of the parent. It is this shift in responsibility that is hypothesized to modify the relationship between adolescent psychological risk factors and probable depression. By stratifying the analyses according to parenthood status, at best we found weak evidence that parenthood modified the strength of the association, with effect estimates and confidence intervals largely overlapping. This is a topical question because, whereas substantial evidence exists supporting the gender gap in prevalence estimates for specific disorders (Kuehner, 2003, 2017) [mainly internalizing vs. externalizing disorders, where the former disorders are generally more common in females (Kuehner, 2017)], there is less evidence to support the possible moderating role of a key event in many people's lives: transitioning to parenthood. One previous study (Lewis et al., 1999) explored how perceived control changes from adolescence to adulthood and how pregnancy in women may reduce or strengthen the association between adolescent LOC and adulthood LOC but did not consider its impact on depression liability. The authors found having a more internal LOC was positively associated with age and that dropping out of school, but not getting pregnant, was negatively associated with developing a more internal LOC (Lewis et al., 1999). In fact, whereas the authors found cross-sectionally that pregnant women or men with pregnant partners felt less in control of their lives, becoming a parent did not moderate the observed increase in internality of locus of control with age. However, when transition to parenthood was accompanied by dropping out of school, the magnitude of the previously observed increase in locus of control with age was reduced. Transition to fatherhood has been under-investigated compared to the transition to motherhood (Recto and Champion, 2020). However, some research has identified dysfunctional cognition and external locus of control as risk factors for the development of depressive symptoms during this transition to fatherhood (Keeton et al., 2008; Sockol and Allred, 2018). Holding dysfunctional cognitions and beliefs may be especially relevant during the transition to parenthood, due to the shift in demands from one's own needs to looking after a dependent child. This new role and responsibility may amplify the impact of negative cognitions linked to low self-worth on mood. These findings seem to preliminarily suggest that intervening on adolescent's LOC and NCS may be beneficial in adolescents transitioning to adulthood, regardless of their parental status, in reducing risk of probable depression later in life. This could potentially have broad societal consequences as depression is an increasingly common mental health problems, affecting a large number of individuals (World Health Organization, 2017). Developing preventative interventions that target LOC and NCS to reduce risk of depression could be warranted if a well-conducted RCT were to confirm our results (see **Box 1** for case example).

Strengths and Limitations

There are several strengths of this study. To our knowledge, this is the largest study that has been conducted to date that has prospectively examined the association between LOC and NCS in adolescence and probable depressive disorder in young adulthood and is the first study to examine these associations in the transition to adulthood and parenthood. Other strengths of this study include the relatively large sample and long-term follow up as compared to previous studies (Richardson et al., 2012), the use of serial measures, and the availability of several important confounding and moderating variables.

However, there are several limitations of this study which should be acknowledged. First, the proportions of missingness were high. Around 68% (537 out of 790) of parents and 24.5% (3,482 out of 14,252) of non-parents or not known parents completed the SMFQ at 23 years of age. This may have biased our results in several ways: first, statistical power was reduced in analyses among parents which resulted in an increased imprecision around our effect estimates (i.e., wider confidence intervals); second, missingness may have introduced differential selection bias in parents compared to non-parents. For example, we may have underestimated depression in parents because the most severe cases may have been less likely to attend a clinic visit. Conversely, we may have overestimated depression in the non-parents because the least vulnerable participants may have been more likely to have moved out of the Bristol area, for example, to study elsewhere, and therefore were more likely to have dropped out or to not have attended clinic visits. Another limitation is that the use of multiple imputation assumes data is MAR, when in fact variables could be missing not at random (MNAR), meaning that missingness may have depended on unobserved data (e.g., depression outcome is missing because participants with depression did not show up to the visit). This could have biased our findings to a larger extent than those obtained from analyses restricted to the complete case dataset (Hughes et al., 2019). Since it is impossible to test whether data are MNAR without relying on further assumptions (Hughes et al., 2019), we cannot be confident in excluding this possibility as the missing data could depend on unmeasured variables. Fourth, moderation analyses often lack statistical power, therefore, to truly understand whether parenthood moderated these associations a larger sample should be employed. Fifth, as in all observational studies, we cannot exclude the possibility of residual confounding due to unmeasured or imprecisely measured confounders in our analyses. One possible solution to minimize the potential role of unmeasured confounders would be to attempt to replicate our analyses in another longitudinal cohort with a known different confounding structure (Richmond et al., 2014). Sixth, we cannot exclude the presence of measurement error. Indeed, the below satisfactory levels of internal consistency [Cronbach's α of 0.57 vs. satisfactory Cronbach's α of 0.60 (Nowicki, 2018)] indicate measurement error in LOC as assessed with the CNSIE at 16 years of age. However, we expect this measurement error to be non-differential and it is therefore likely to represent an underestimate of the true effect. Finally, we cannot exclude the possibility of chance findings and this likelihood increases with multiple hypotheses being tested. We conducted multiple tests in these analyses, however only four tests constituted primary analyses (the remaining tests were sensitivity analyses performed to examine the robustness of our findings). We did not employ corrections for multiple testing as this could be overly conservative because of non-independence of our hypotheses examined. Furthermore, we do not make categorical interpretations based on *p*-values but rather report the overall patterns of findings and strength of evidence.

In conclusion, replication of our findings in larger and more diverse samples and using different methods (e.g., RCTs) is required to refine the understanding of the evidence around the causal role of LOC and NCS in depression onset. In particular, having a large sample (e.g., with sufficient numbers of both fathers and mothers in the sample) would allow differential investigation of the relationship between LOC and NCS with probable depression in mothers and fathers separately.

Implications

Adolescents are a key risk group and current global target for supportive interventions. Adolescence provides a privileged time-window opportunity for preventive interventions because, thanks to universal schooling, there is the possibility of early and associated screening and opportunity of receiving psychological support. This study suggests that interventions targeting LOC and NCS in adolescents could prevent young adulthood depression in parents, expectant parents and non-parents.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: ALSPAC datasets can be accessed pending approval of research proposals. Requests to access these datasets should be directed to alspac-data@bristol.ac.uk, bbl-info@bristol.ac.uk.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and South West National Health Service (NHS) Research Ethics Committee; participants gave written informed data consent. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JG established the ALSPAC study and managed data collection, including for several of the variables used here. RP and IC contributed to conception and design of the study. ML and DL managed data collection in the ALSPAC-G2 study. IC performed the statistical analysis and wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.599240/full#supplementary-material

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The Association Between Locus of Control and Psychopathology: A Cross-Cohort Comparison Between a UK (Avon Longitudinal Study of Parents and Children) and a Japanese (Tokyo Teen Cohort) Cohort

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Background: An external locus of control (externality) is associated with poorer psychopathology in individualist cultures, but associations are reported to be weaker in collectivist cultures where an external style is less maladaptive. We investigated the prospective association between externality and psychotic-like experiences (PLE) and depressive symptoms (DS) and compared the strength of associations between a UK and a Japanese cohort.

Method: Cross-cultural cohort study of a UK (Avon Longitudinal Study of Parents and Children) and a Japanese cohort (Tokyo Teen Cohort). Externality was assessed using the Children's Nowicki and Strickland Internal, External Scale and DS using the Short Moods and Feelings Questionnaire in both cohorts, PLE were assessed with the Psychosis-Like Experiences Questionnaire (ALSPAC), and the Adolescent Psychotic-Like Symptom Screener (TTC). Associations were investigated using multivariable regression models and bivariate regression models to compare the strength of associations.

Results: Mean externality in both childhood and adolescence was higher in ALSPAC than in the TTC. Childhood externality was associated with PLE in late childhood and adolescence in both cohorts and adolescent externality was associated with PLE in young adulthood in the ALSPAC cohort. There was a more mixed pattern of association between externality and DS scores. There was little evidence of any differences in the strength of associations between externality and different psychopathologies, or between cohorts. In ALSPAC adolescent externality and early adult psychopathology were more strongly associated than childhood externality and adolescent and early adult psychopathology. There was no evidence that change in externality between childhood

and adolescence was associated with new onset PLE or DS in early adulthood.

Conclusion: An external locus of control is associated with poor mental health regardless of cultural context.

Keywords: psychotic-like experiences, locus of control, externality, ALSPAC, depression

BACKGROUND

The concept of "locus of control" was first defined by Rotter (1966), where he described it as "a generalized problem-solving expectancy functioning within social theory" (Nowicki et al., 2018a). Locus of control (LoC) is a term used to describe the extent to which a person believes that they have control over events and outcomes, in other words whether they have "agency" (Nowicki et al., 2018a). Its role in the link between negative events and psychopathology has been reported both as a moderator (i.e., changing the strength and nature of the relationship) and a mediator (mechanism that explains the relationship) (Liu et al., 2000; Culpin et al., 2015). LoC style is not innate but learnt through reinforcement and social interaction (Rotter, 1966). For this reason the meaning given to LoC is considered to be culturally influenced (Cheng et al., 2013). For instance, in individualist societies (such as the US and UK) where achievement of one's own goals is considered paramount, an externalized LoC where agency is lacking, has negative connotations (Markus and Kitayama, 1999). However, in more collectivist societies (such as many South East Asian communities) achievement of the goals of the group are considered to be more important than achievement of personal goals, and one's identity is constructed via the group rather than the individual. There is evidence that mean externality scores are higher in collectivist societies (Cheng et al., 2013) and members of societies with collectivist cultures are therefore more tolerant of external control (Markus and Kitayama, 1999).

To have an externalized LoC is to believe that one has little personal control and that outcomes and events can be attributed to outside forces such as other people and chance (Rotter, 1966). Conversely, to have an internalized LoC is to believe that one has control over events and outcomes (Rotter, 1966; Pagnini et al., 2016). An internalized LoC has been shown to be adaptive and associated with higher levels of well-being (Chorpita and Barlow, 1998), perhaps because it can be used as a coping strategy (Cheng et al., 2013). An externalized LoC reduces propensity to engage in problem-solving activities (Cheng et al., 2013) and has been linked to depression, anxiety and psychotic like experiences (PLE) in adults and adolescents (Sullivan et al., 2017). It is important to establish whether a more external LoC has a causal effect on psychopathology (Kurtovic et al., 2018) particularly as, there is evidence (Jarrett et al., 2007) that LoC style is modifiable with appropriate psychological therapy.

There are some aspects of the relationship between LoC and psychopathology, which are currently under-explored. Firstly, whilst most previous research has examined the link between LoC style (internal or external) and depression and anxiety, less work has focussed on the association with PLE. It is important to investigate this link because LoC has a major influence on constructions of reality, the concept of self, and representations about others, all of which are impaired in clinical psychosis and in people with PLE in general population samples (Bentall et al., 1994; Donohoe et al., 2008; Langdon et al., 2010). Many of the positive symptoms of psychosis, such as hallucinations and delusions are associated with a loss of contact with reality and a blurring of the boundary between the self and the outside world (Cicero et al., 2016). For example, auditory hallucinations are hypothesized to arise as a result of misattributing internal thoughts or memories as an external "voice" emanating from another person. On the other hand, externality is also associated with feelings of helplessness arising from a belief of lack of control, which is a common feature of depression (Chorpita, 2001).

Secondly, very little work has compared whether the association between LoC and PLE is of a similar magnitude to that between LoC and depressive symptoms (DS). This is important because PLE and DS frequently co-occur (Sullivan et al., 2014) and therefore many risk factors are common to both. It is important to unpick the complex associations between risk factors for PLE and comorbid DS to better inform the etiology and mechanism of PLE and DS, help to detect those at specific risk and inform interventions that may help to reduce the incidence of psychosis and depression. A direct comparison of the effect size between externality and PLE and DS using appropriate statistical methods that allow for overlap in the outcomes, will facilitate an estimate of whether externality is a more important risk factor for PLE or DS.

Thirdly, less research has been conducted on the link between LoC style and psychopathology in children and adolescents than in adults, There is evidence (Nowicki et al., 2018b) that externality reduces with maturity in healthy populations. It is important to clarify whether the same relationships between LoC style exist in children and adolescents as in adults because most mental health problems have their origins in late childhood and early adolescence (Kessler et al., 2007) and it is at this stage of life when early intervention is likely to have the best long-term result.

Fourthly, most research has been carried out in the UK and US where the culture is more individualist, which does not elucidate the relationship in populations with collectivist cultures (Cheng et al., 2013; Moreira et al., 2020). There is some cross-sectional evidence that people in collectivist counties report higher external LoC scores and that LoC scores show weaker associations with psychopathology (Cheng et al., 2013). It is important to compare the relationship between externality and psychopathology across cultures because the importance of externality in the etiology of these mental health problems may not be universal, but culturally dependent.

Lastly, most previous research into externality and mental health problems has been cross-sectional and cannot provide insight into the temporal sequence of LoC style and psychopathology. The authors are only aware of relatively few previous longitudinal studies (Frenkel et al., 1995; Harrow et al., 2009; Thompson et al., 2011; Wiersma et al., 2011; Culpin et al., 2015). Two (Thompson et al., 2011; Culpin et al., 2015) were conducted in one of the same cohorts as the study described here, but one (Culpin et al., 2015) investigated the association of LoC as a mediator between adverse events and depression and the other (Culpin et al., 2015) the association between childhood LoC and PLE at age 12. A further study (Wiersma et al., 2011) only investigated the association between LoC and depression and the remaining two had small ($n = 89$ and 128) sample sizes.

Given the problem of inferring causality in observational research, cross-cultural studies provide especially valuable evidence as these can help determine whether residual confounding is present. Cohorts in countries which are culturally and ethnically diverse are likely to have different confounding variable structures. If the same, or similar, findings are established in two cohorts with different confounding structures, confidence that associations are causal is increased (Richmond et al., 2014). This method has been used in epidemiological studies examining whether the effect of maternal age on birthweight and gestational age is causal or due to confounding (Restrepo-Mendez et al., 2015). Cross cultural cohort comparisons are further strengthened if the instruments used to measure risk factors and outcomes are the same or similar (Richmond et al., 2014).

Little research has been carried out into individual change in externality over time in children except by Nowicki et al. (2018a). Children with a normal developmental course should become more internal over time as they acquire more control over their surroundings as they mature. Hypothetically therefore, those with stable or increasing externality may have a different developmental trajectory from their peers.

There is some recent unpublished evidence in a UK general population cohort that an externalized LoC during childhood and adolescence is a risk factor for new onset of PLE between late adolescence and early adulthood. It would be informative to investigate whether an increase in externality over time is also associated with new reports of PLE.

This study aims to investigate and compare the longitudinal associations between externality and both PLE and DS in children and adolescents in a UK general population cohort (Avon Longitudinal Study of Parents and Children, ALSPAC) and a Japanese general population cohort (Tokyo Teen Cohort, TTC).

We predicted that: (1) Externality in childhood and adolescence would be associated with PLE and DS in adolescence and early adulthood in both cohorts, but that the association between externality in adolescence and psychopathology in early adulthood would be stronger than that between childhood externality and psychopathology in early adolescence; (2) The association between externality and PLE would be stronger than that between externality and DS in both cohorts; (3) The associations between externality and PLE and DS would be stronger in the ALSPAC cohort compared to the TTC cohort; (4) An increase in externality between childhood and adolescence would be associated with new onset PLE and DS in early adulthood.

METHODS

Samples

The Avon Longitudinal Study of Parents and Children (ALSPAC) was designed to determine the environmental and genetic factors that are associated with the health and development of the study offspring (Boyd et al., 2013; Fraser et al., 2013; Northstone et al., 2019). ALSPAC recruited 14,541 pregnant women residing in Avon, an area of south-west England, with expected dates of delivery between 1st April 1991 and 31st December 1992. Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14, 062 live births, 13, 988 of whom were alive at 1 year of age. Data were collected at various time-points using self-completion questionnaires, biological samples, hands-on measurements, teacher reports, and linkage to other data sets. Please note that the study website contains details of all available data through a fully searchable data dictionary http://www.bristol.ac.uk/alspac/researchers/our-data/.

The self-report data of the cohort from age 22 were collected using REDCap (2020).

Tokyo Teen Cohort (TTC), http://ttcp.umin.jp/index.html, is a longitudinal survey of children and adolescents. Details of the TTC are described elsewhere (Yamasaki et al., 2019). A sample of 3,171 households with children aged 10 years who were born between September 2002 and August 2004 were randomly chosen from residential registries of three municipalities (Chofu, Mitaka, and Setagaya) in Tokyo, Japan. When these children were 12 years old 3007 households participated in the second wave of the study (follow-up rate: 94.8%). Trained interviewers visited the participants' home twice during each wave. On the first visit, the interviewers obtained written informed consent from the adolescents' primary parent and asked them to complete a set of questionnaires. On the second visit, they conducted assessments including semi-structured interviews and neuropsychological tests and measured anthropometric data. When the participants were 14 years old 2,667 households (84.1%) participated in the third wave of data collection when similar assessments were conducted to the first two waves.

For the purposes of this investigation in both cohorts we used a subset who had provided data on LoC, PLE, DS and relevant confounding variables at various timepoints (**Figures 1A,B**).

Ethics

Ethic approval for this study was obtained from the ALSPAC Ethics and Law Committee (ALEC; IRB00003312) (registered on the Office of Human Research Protections database as U Bristol IRB #1), and the Local Research Ethics Committees. The Committees agreed that consent was implied if questionnaires were returned.

The study protocol of the TTC was approved by the institutional review boards of Tokyo Metropolitan Institute of Medical Science, SOKENDAI (Graduate University for Advanced Studies), and the University of Tokyo.

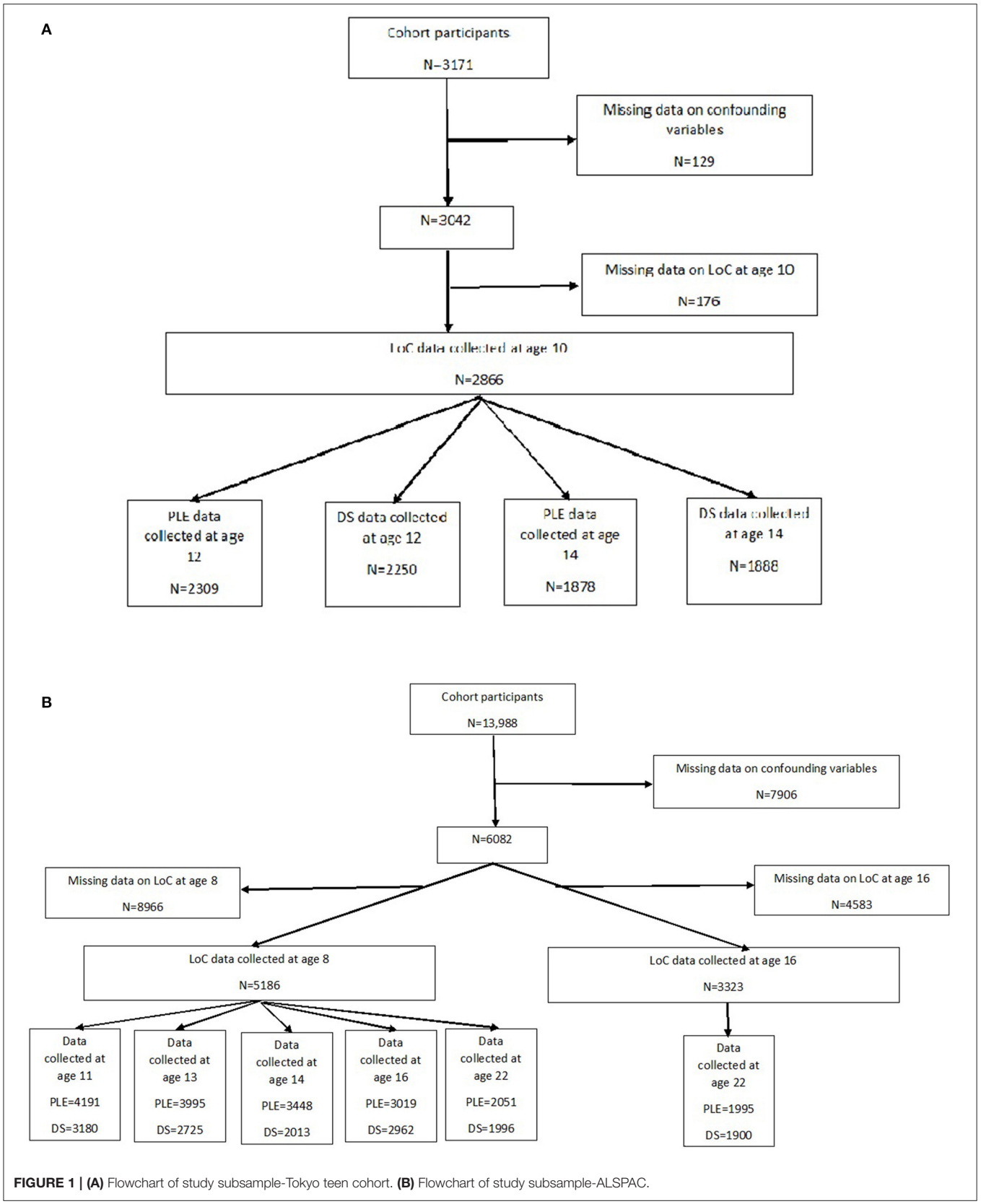

FIGURE 1 | (A) Flowchart of study subsample-Tokyo teen cohort. **(B)** Flowchart of study subsample-ALSPAC.

Outcome Measures

Psychotic-Like Experiences

Tokyo Teen Cohort

Assessed using the self-report questionnaire—Adolescent Psychotic-Like Symptom Screener (APSS) (Kelleher et al., 2011) at 12 and 14 years. The APSS is a 7-item measure consisting of 4 questions from the Diagnostic Interval Schedule for Children (Shaffer et al., 2000) ("have you ever heard voices that no one else can hear?," "have you ever thought that people are following or spying on you?," "have other people ever read you mind?," "have you ever had special messages sent to you through TV or radio?") and 3 additional questions on, visual hallucinations, delusions of control and grandiosity. At age 12 only 5 of the questions (auditory and visual hallucinations, paranoia, and delusions of others reading your mind and reference) were asked. At 14 years all seven questions were asked, plus two extra questions on body dysmorphia and delusion of reading others' minds. For each question the respondent was asked about their lifetime experience and there were three possible responses: yes definitely, yes maybe and no. At 14 years only, questions were also asked about distress (fine, a little distressing, very distressing) and frequency (if definite: only once and twice or more). The APSS has good sensitivity and specificity in identifying young people who had PLE that were subsequently identified by clinical interview (Kelleher et al., 2011). For the purposes of analysis a binary variable was defined at each timepoint consisting of definite PLE vs. maybe/no PLE.

ALSPAC

Assessed using the child/adolescent/adult completed PLIKS-Q questionnaire at 5 timepoints: 11.5, 13, 14, 16.5, and 22 years. The PLIKS-Q is a specially designed questionnaire, based on the PLIKS-I interview (Horwood et al., 2008), asking about lifetime occurences, level of conviction (definitely or maybe), past year frequency ("none," "<once per month," "≥monthly") and the attribution of the PLE. The PLE enquired about were visual, and auditory hallucinations, beliefs about being spied on, beliefs that others were using special powers to read their thoughts, beliefs that they were being sent special messages, or beliefs that some special power was controlling them. At 11.5 years 7 questions were asked, at 13, 14, and 16.5 years 11 questions were asked and at 22 years 3 questions were asked about the number of different PLE.

The data at each timepoint, in each cohort, were coded as binary (present if the respondent endorsed a PLE as having ever definitely occurred and absent if it was endorsed as only maybe occurring or not present).

Severity of PLE

A 5-category variable indexing the severity of PLE was created using information on frequency and distress caused by PLE. The categories were none, maybe, definite but not distressing or frequent, definite, and distressing (quite or very) OR frequent (at least monthly), definite and distressing (quite or very) AND frequent (at least monthly). This variable was defined in ALSPAC at 14, 16, and 22 years and in TTC at 14 years. The frequency categories collected by the TTC at 14 years were different from ALSPAC so the highest frequency category (at least twice) was used to allow a more direct comparison between cohorts.

Depressive Symptom Scores

DS scores were collected in both the ALSPAC and Tokyo Teen Cohort using the Shortened Moods and Feelings Questionnaire (Angold et al., 1995) at 10, 12, and 14 years (TTC) and 11, 13, 14, 16, and 22 years (ALSPAC). Thirteen questions were asked about how the participant had been feeling over the past 2 weeks with possible responses of not true (score = 0), sometimes true (score = 1), and always true (score = 2). For the purposes of analysis the total DS score was used (range 0–26). Higher scores indicated worse DS. In both cohorts the questions were self-completed by participants.

For the bivariate analysis described below a binary measure of depression was derived using a cut-off score of ≥11 to allow statistical modeling alongside the binary PLE variable. This cut off has been shown to have a high specificity and sensitivity (Thapar and McGuffin, 1998) and has been previously applied in community samples (Copeland et al., 2009).

New Onset PLE and Depression

New onset PLE in the ALSPAC cohort was defined as having PLE occurring at least once since age 20 at the age 22 assessment but not ever in the previous assessments. New onset depression (see binary variable definition above) was defined as meeting the criteria for depression in the 2 week period prior to the age 22 assessment, but not in the previous assessments.

This analysis was not carried out in the TTC because LoC was only measured at two timepoints (10 and 14 years) and there were no further measures of PLE and DS after age 14 years.

Exposure Measure

Locus of Control

The Children's Nowicki and Strickland Internal, External Scale (CNSIE) (Nowicki and Strickland, 1973) originated from an administration of the 40-item test to a sample of 120 8 year olds, following which the 12 items with the best item-total correlation were chosen for inclusion in the final form administered to both cohorts. With regard to discriminative validity, the CNSIE showed little evidence of associations with social desirability (Nowicki and Strickland, 1973) and with regard to construct validity, there was evidence of moderate relations between the CNSIE and other measures of LoC (e.g., Intellectual Achievement Responsibility and Bailer-Cromwell scales) (Nowicki and Strickland, 1973). There is also evidence of association between internality and higher academic achievement (Nowicki and Strickland, 1973).

In ALSPAC, LoC was measured in participants at 8 and 16 years of age. When cohort participants were 8 years old the questions were read aloud to participants by an interviewer to eliminate differences in reading ability. At 16 years of age the questionnaires were self-completed without any assistance. In the TTC LoC was assessed at 10 and 14 years of age. The CNSIE was self-completed by participants. Externality score in these measures was calculated as the number of external responses. Higher scores represented a more externalized style.

We also calculated a variable for change in LoC. For the ALSPAC cohort we subtracted the scores at 8 from the scores at 16 years. For the Tokyo Teen cohort we subtracted the scores at 10 years from those at 14 years. Negative scores represented a decrease in externality (an increase in internality) over time, whereas positive scores represented an increase in externality (a decrease in internality).

Confounders

The choice of covariates was informed by the literature. Gender, socio-economic status (highest parental education, home ownership status, income, mother's marital status) (see **Supplementary Table A** for details) and IQ (measured using the Weschler Intelligence Score for Children) were selected. As far as possible similar variables were chosen in each cohort (see **Supplementary Table B** for cross-cohort comparison). In ALSPAC the covariates were measured at the child's birth, except for IQ which was assessed at age 8. In TTC the covariates were measured at baseline when the child was 10 years of age. To define family income the variable was dichotomised at the top 30% of income in both cohorts to remove the effect of currency differences. In ALSPAC mothers were asked if they were married to the child's father when the child was born whereas in the TTC mothers were asked if they lived with the child's father when the child was born.

Statistical Analysis

For all analyses, the same complete cases sample was used for both the univariable and multivariable models. The sample size varied for each model depending on the timepoint of the exposure and outcome investigated. Univariable and multivariable logistic regression was used to investigate the association between externality and PLE (ALSPAC externality at 8 years and PLE at 11, 13, 14, 16, and 22 years: TTC externality at 10 years and PLE at 12 and 14 years) and univariable and multivariable linear regression to investigate the association between externality and DS scores (ALSPAC externality at 8 years and DS scores at 11, 13, 14, 16, and 22 years: TTC externality at 10 years and DS scores at 12 and 14 years). Univariable and multivariable logistic regression were used to investigate the association between change in externality and new onset PLEs and depression (using the $\geq$11 SMFQ cut off). We used a bivariate probit analysis to jointly model the outcomes of PLE and depression (using the $\geq$11 SMFQ cut off) to compare the strength of association between externality and PLE and depression whilst allowing for overlap between outcomes. We used a Wald test to provide evidence against the null hypothesis that the estimates of association were equal for each outcome. A small Wald Test *p*-value would indicate strong evidence against the null hypothesis. Probits were converted to odds ratios for ease of interpretation by exponentiating and then multiplying by 1.6 (Amemiya, 1981). An ordinal logistic regression analysis was used to analyse the association between externality and severity of PLE.

RESULTS

Cross-Cohort Descriptive Statistics (Table 1)

Both sexes were almost equally represented in each cohort although the proportion of males in the TTC was higher. Mean IQ and the proportion of parents owning their home was similar across cohorts, although the proportion of parents who had completed higher education was much higher in the TTC compared to ALSPAC.

In the TTC the mean externality score was 3.99 (SD 1.92) at age 10 and at age 14 it was 3.63 (SD 1.92). In the ALSPAC cohort, the mean externality score at age 8 was 6.00 (SD 2.07) and at 16 years it was 4.18 (SD 2.11). In both cohorts the mean externality score decreased with age. The mean decrease per year in ALSPAC was 0.21 per year and in the TTC it was 0.08 per year. This finding should be interpreted cautiously because it assumes that the change over time is linear across all ages and in both cohorts, which may not be the case.

The proportion of those depressed (SMFQ score $\geq$11) was very similar in ALSPAC at 11 years and TTC at 12 years but higher in ALSPAC at 14 years compared with the TTC at the same age. In ALSPAC the proportion defined as depressed increased between 11 and 13 and remained higher than the TTC, whereas in the TTC the proportion defined as depressed decreased between 12 and 14 years.

The proportion with PLE was lower in the TTC compared with ALSPAC at 11 and 12 years but more comparable at 14 years. In both cohorts the proportion reporting PLE decreased over time. The proportions of those in the most severe PLE category (i.e., definite, frequent, AND distressing) was higher in the TTC than ALSPAC at 14 years, although there was a higher proportion in TTC who had not reported any PLE. See **Supplementary Table C**.

Cross Cohort Comparison of Association Between Externality and PLE

Externality scores were normally distributed in both cohorts. Externality in childhood and adolescence was associated with PLE at all time points and adjusting for covariates had little effect on the estimates. The strength of associations reduced as the length of time between the LoC measure and outcome increased. The strength of association between externality and PLE ranged from a 5% to a 26% increase in odds of PLE for each point increase in externality score. The association was stronger in the TTC compared to ALSPAC but all confidence intervals overlapped. See **Table 2A**.

There was no evidence that change in externality between 8 and 16 years in the ALSPAC cohort was associated with new onset of PLE in early adulthood. See **Table 3**.

In both cohorts there was strong evidence that the association between higher externality scores and PLE becomes stronger with increasing severity of experiences. In the TTC the association was 2.4 times stronger between the least severe (maybe) and the most severe (distressing and frequent) PLE category, whereas in ALSPAC the difference ranged from nearly 3 to 6 times stronger (**Table 4**).

TABLE 1 | Description of all variables across cohorts.

Measure	Scale	Analysis units	Sample *n*	*n* (%)/mean (SD) exposed	Scale	Analysis units	Sample *n*	*n* (%) exposed
	ALSPAC				Tokyo teen cohort			
Confounders								
Sex	Binary	Female	7,156	3,573 (49.9%)	Binary	Female	3,171	1,487 (46.9%)
IQ	WISC range (74–151)		7,156	Mean 102.3 (SD 21.6)	WISC range (50.9–144.3)		3,168	Mean 107.7 (SD 14.1)
Homeownership status of mother at child's birth	Binary	Mortgaged or owned	12,993	9,529 (70.8%)	Binary	Homeownership of parent's asked when child 10 years old	3,164	2,212 (69.9%)
Marital Status of mother at child's birth	Binary	Married at child's birth	13,053	9,780 (75.0%)	Identity of partner from child's perspective at 10 years old	Biological father-asked when child 10 years old	3,171	3,121 (98.4%)
Highest maternal education level at child's birth	Binary	Higher education at child's birth (A levels/degree)	12,383	4,378 (33.4%)	Binary	At least one parent completed higher education asked when child age 10 years old	3,170	2,257 (71.2%)
Average household income when child 33 and 47 months	Binary	Top 30%			Binary	Household income when child 10 years old–top 30% of cohort over previous year	3,046	917 (30.11%)
Risk factors								
Locus of control @ 8 (0-12)	CNSIE		6,101	Mean 6.00 (SD 2.07)				
Locus of control @ 10 (0–12)					CNSIE		2,983	Mean 3.99 (SD 1.92)
Locus of control @ 14 (0–12)							2,399	Mean 3.63 (SD 1.9)
Locus of control @ 16 (0–12)			4,772	Mean 4.20 (SD 2.12)				
Outcomes								
Depression @ 11 years	SMFQ	Depressed ≥score of 11	5,716	516 (9.03%)				
Depression @ 12 years					SMFQ	Depressed ≥score of 11	2,479	233 (9.4%)
Depression @ 13 years			4,248	770 (18.1%)				

(Continued)

TABLE 1 | Continued

Measure	Scale	Analysis units	Sample *n*	*n* (%)/mean (SD) exposed	Scale	Analysis units	Sample *n*	*n* (%) exposed
		ALSPAC				**Tokyo teen cohort**		
Depression @ 14 years			3,187	585 (18.4%)			2,070	169 (8.2%)
Depression @ 16 years			4,773	885 (17.9%)				
Depression @ 22 years			3,149	569 (18.1%)				
New onset depression @ 22		Depressed ≥score of 11 over previous 2 weeks but not at previous timepoints	1,319	53 (4.0%)				
PLE ever @ 11	PLIKSQ Binary	Definite vs. maybe/no	7,173	1,860 (25.9%)				
PLE ever @ 12					APSS binary	Definite vs. maybe/no	2,539	458 (18.0%)
PLE ever @ 13			6,758	1,116 (16.5%)				
PLE ever @ 14			5,719	741 (13.0%)			2,062	345 (16.7%)
PLE ever @ 16			4,884	648 (13.3%)				
PLE ever @ 22			3,242	196 (6.1%)				
New onset PLE @ 22		More than once since 20th birthday but no previous reports at earlier ages	2,158	35 (1.6%)				
Severity of PLE @ 14	PLIKSQ 5 category	None	5,718	3,330 (58.2%)	APSS 5 category	None	2,061	1,519 (73.7%)
		Maybe		1,712 (29.9%)		Maybe		326 (15.8%)
		Definite but not distressing or frequent		287 (5.0%)		Definite but not distressing or frequent		29 (1.4%)
		Definite and distressing OR frequent		302 (5.3%)		Definite and distressing OR frequent		103 (5.0%)
		Definite and distressing AND frequent		87 (1.5%)		Definite and distressing AND frequent		84 (4.1%)
Severity of PLE @ 16	PLIKSQ 5 category	None	4,884	3,260 (66.8%)				
		Maybe		1,042 (21.3%)				

(Continued)

TABLE 1 | Continued

Measure	Scale	Analysis units	Sample *n*	*n* (%)/mean (SD) exposed	Scale	Analysis units	Sample *n*	*n* (%) exposed
		ALSPAC				**Tokyo teen cohort**		
		Definite but not distressing or frequent		276 (5.7%)				
		Definite and distressing OR frequent		247 (5.1%)				
		Definite and distressing AND frequent		59 (1.2%)				
Severity of PLE @ 22	PLIKSQ 5 category	None	3,242	2,571 (79.3%)				
		Maybe		475 (14.7%)				
		Definite but not distressing or frequent		100 (301%)				
		Definite and distressing OR frequent		71 (2.2%)				
		Definite and distressing AND frequent		25 (0.77%)				

TABLE 2A | Multivariable* associations between externality and PLE.

Timepoint of PLEs data collection years	**11**			**12**			**13**			**14**			**16**			**22**		
	OR	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***p***
ALSPAC																		
Sample size n	4,190						3,995			3,48			3,019			2,051/1,955		
Externality @ 8	1.06	1.02–1.10	0.002				1.08	1.03–1.13	≤0.0001	1.07	1.01–1.11	0.047	1.06	1.00–1.12	0.062	1.04	0.94–1.14	0.471
Externality @ 16																1.26	1.15-1.38	≤0.0001
TTC																		
Sample size n				2,309						1,878								
Externality @ 10				1.12	1.06–1.19	≤0.0001				1.11	1.04–1.18	0.002						

*Complete cases. Univariable results in **Supplementary Table E**.*

**Adjusted for sex, IQ at age 8, home ownership status, parental marital status, parental educational level, family income.*

TABLE 2B | Multivariable* associations between externality and sFMQ score (0–26).

Timepoint of sMFQ data collection (years)	**11**			**12**			**13**			**14**			**16**			**22**		
	β	**95% CI**	***p***	***β***	**95% CI**	***p***	***β***	**95% CI**	***p***	***β***	**95% CI**	***p***	***β***	**95% CI**	***p***	***β***	**95% CI**	***p***
ALSPAC																		
Sample size n	3,810						2,725			2,150			3,156			1,996/1,900		
Externality @ 8	0.14	0.07–0.21	≤0.0001				0.080	−0.02–0.17	0.100	0.13	0.004–0.225	0.43	0.13	0.03–0.22	≤0.0001	0.11	−0.01–0.230	0.071
Externality @ 16																0.58	0.46-0.70	≤0.0001
TTC																		
Sample size n				2,250						1,888								
Externality @ 10				0.34	0.24–0.44	≤0.0001				0.20	0.08–0.31	0.001						

*Complete cases. Univariable results in **Supplementary Table F**.*

**Adjusted for sex, IQ at age 8, home ownership status, parental marital status, parental educational level, family income.*

TABLE 3 | Univariable and Multivariable* association between change in externality between 8 and 16 (−9–8) and new onset PLE and depression between 16 and 22 (reported at 22 but not at 16, 14, 13, or 11).

	n	Unadjusted OR	95% CI	*p*	Adjusted OR	95% CI	*p*
New onset PLE @ 22	1,418	1.05	0.90, 1.23	0.514	1.02	0.87, 1.20	0.769
New onset depression @ 22	947	1.02	0.90, 1.15	0.811	0.970	0.849, 1.108	0.657

Complete cases (ALSPAC only).
**Adjusted for sex, IQ at age 8, home ownership status, parental marital status, parental educational level, family income.*

Cross Cohort Comparison of Association Between Externality and DS

There was evidence of an association between externality score and DS score in both cohorts at all timepoints, although at the earlier timepoint the association in the TTC (externality at age 10 and DS at age 12) was stronger than in ALSPAC (externality at age 8 and DS at age 11) whereas at the later timepoint (TTC: externality at age 10 and DS at age 14 and ALSPAC: externality at age 8 and DS at age 14) the strength was similar. Predictably, as the time-period between measurement of externality and DS scores increased the estimate of association weakened. In ALSPAC the association between externality in mid adolescence (16 years of age) and DS in young adulthood was about 4 times stronger than that between externality in childhood (8 years of age) and DS in mid adolescence (at 16 years of age) even though the time-period of measurement between risk factor and outcome was the same (6 years; **Table 2B**).

There was no evidence of an association between change in externality between 8 and 16 years in the ALSPAC cohort and new onset of depression at 22 years. See **Table 3**.

Comparison of Strength of Association Between Externality and Psychopathology (Table 5)

There was no evidence, in either cohort, of any difference in the strength of association between externality score and PLE compared to that between externality score and depression.

DISCUSSION

As far as the authors are aware this is the only study to investigate the longitudinal association between externality in childhood and adolescence and PLE and DS in adolescence and early adulthood in a UK (individualist) and a Japanese (collectivist) cultural setting.

As predicted, we found strong evidence of an association between externality and PLE and DS in both cohorts and evidence in the ALSPAC cohort that these associations were stronger between adolescent externality and early adult psychopathology than between childhood and adolescent psychopathology. However, contrary to our prediction there was no evidence that the association between externality and PLE was stronger than that between externality and DS in either cohort or that the associations were stronger in the ALSPAC compared to the TTC cohort. Neither did we find that increasing externality between childhood and adolescence was associated with new onset PLE or DS in the ALSPAC cohort but there was evidence that the association between externality and PLE was stronger as the severity of PLE increased.

As described above and contrary to our hypotheses and the findings of others (Lu et al., 2000) we did not find that mean externality scores were higher in the Japanese cohort nor that the association between externality and psychopathology was weaker when compared with the UK cohort. Others (Kozma and Stones, 1987) have suggested that externality self-report measures may be prone to measurement error because of social desirability. For example, participants from individualist countries may be less likely to endorse externality because they consider it to be an undesirable trait. In contrast, we found ALSPAC participants to have a higher mean externality score than TTC participants.

Our finding of a moderately strong association between externality and DS was similar to that found by others (Cheng et al., 2013; Culpin et al., 2015; Moreira et al., 2020). A meta-analysis (Cheng et al., 2013) found a weaker association between externality and DS for collectivist compared to individualist cultures, which was not replicated in our study.

Our finding of a strong association between externality and PLE reinforces the findings of others (Thompson et al., 2011; Sullivan et al., 2017) using ALSPAC data. One of these studies (Sullivan et al., 2017) found weak evidence of a stronger association between externality at age 8 and PLE compared with depression at age 12 years. This was not replicated in our findings, which might be because a different tool was used to measure PLE. In the Sullivan 2017 study (Sullivan et al., 2017) data from a semi-structured clinical interview was used, whereas in the current work PLE data were collected using a self-report questionnaire. The semi-structured interview method allows the interviewer to probe the answer provided by the respondent using further questions. It could be hypothesized therefore, that there is more measurement error when PLE data are collected by self-report. This measurement error is likely to be non-differential with respect to LoC, and therefore will dilute any association between our exposure and outcomes, and may be why we failed to detect a difference in the strength of association of externality between PLE and depression. This assumes that self-report assessment of DS is more accurate than that of PLE. There is some evidence (Stuart et al., 2014) in favor of this.

Hypothetically, the association between externality and psychopathology should be stronger at later ages because as children mature, they acquire greater control over their environment and themselves and naturally become less externalized. In other words, externality in childhood is less abnormal than during adolescence and hence the associations of externality with PLE and DS might be expected to be weaker in childhood. Although externality decreased with age as expected

TABLE 4 | Association between severity of PLE (5 categories) and externality.

Timepoint of PLE data collection (years)		14				16				22			
		Unadjusted		Adjusted*		Unadjusted		Adjusted*		Unadjusted		Adjusted*	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
ALSPAC													
Sample size n		3,704				3,221				2,199/ 2,066			
Externality @ 8	None (ref cat)	1		1		1		1		1		1	
	maybe	0.76	(0.57, 0.96)	1.23	(1.00, 1.45)	1.23	(1.00, 1.45)	2.02	(1.34, 2.70)	1.90	(1.58, 2.23)	1.45	(0.48, 2.42)
	Definite but not distressing or frequent	2.44	(2.22, 2.65)	2.58	(2.34, 2.83)	2.58	(2.34, 2.83)	3.39	(2.71, 4.07)	3.20	(2.85, 3.55)	2.75	(1.77, 3.73)
	Definite and distressing OR frequent	3.06	(2.83, 3.29)	3.24	(2.98, 3.50)	3.24	(2.98, 3.50)	4.05	(3.36, 4.74)	3.92	(3.53, 4.31)	3.47	(2.48, 4.47)
	Definite and distressing AND frequent	4.56	(4.24, 4.89)	4.81	(4.43, 5.18)	4.81	(4.43, 5.18)	5.62	(4.88, 6.36)	5.44	(4.84, 6.03)	5.00	(3.91, 6.09)
Sample size *n*		3,221											
Externality @ 16	None (ref cat)									1		1	
	Maybe									2.56	(2.30, 2.83)	2.45	(1.50, 3.40)
	Definite but not distressing or frequent									3.94	(3.62, 4.25)	3.83	(2.86, 4.79)
	Definite and distressing OR frequent									4.60	(4.24, 4.96)	4.49	(3.51, 5.47)
	Definite and distressing AND frequent									6.11	(5.52, 6.69)	6.01	(4.91, 7.09)
TTC													
Sample size n	1,877												
Externality @ 10	None (ref cat)	1		1									
	Maybe	1.43	(1.19, 1.66)	1.50	(0.54, 2.45)								
	Definite but not distressing or frequent	2.54	(2.28, 2.80)	2.60	(1.63, 3.56)								
	Definite and distressing OR frequent	2.71	(2.44, 2.97)	2.76	(1.80, 3.73)								
	Definite and distressing AND frequent	3.54	(3.23, 3.85)	3.61	(2.63, 4.59)								

**Adjusted for sex, IQ at age 8, home ownership status, parental marital status, parental educational level, family income.*

TABLE 5 | Main effects (OR and 95% Cis) of externality on depression and PLE.

	Age	Depression		PLE		Wald test of common effect *p*
		OR	95% CI	OR	95% CI	
ALSPAC						
Externality@8 years	11	1.04	1.00, 1.09	1.07	1.03, 1.11	0.300
	13	1.06	1.02, 1.11	1.12	1.07, 1.17	0.083
	14	1.10	1.05, 1.16	1.06	1.00, 1.12	0.244
	16	1.07	1.03, 1.11	1.05	1.00, 1.09	0.326
	22	1.04	1.00, 1.09	1.04	0.98, 1.11	0.998
Externality@16 years	22	1.81	1.76, 1.86	1.79	1.72, 1.86	0.623
TTC						
Externality@10 years	12	1.12	1.06, 1.19	1.11	1.06, 1.17	0.777
	14	1.10	1.03, 1.18	1.09	1.03, 1.15	0.834

in both cohorts, it decreased less per year in the TTC than in ALSPAC and in fact externality in ALSPAC remained at a higher level than in the TTC at later ages. In the main, there was little difference in the strength of association between externality and psychopathology at later compared to earlier ages in either cohort.

A possible explanation for the lack of support for our prediction that the association between externality and psychopathology would be weaker in the TTC than that in ALSPAC is the contemporary nature of the TTC data compared to the ALSPAC data. Externality data in ALSPAC was collected ∼22 (LoC at age 8) and 14 (LoC at age 16) years ago, whereas the TTC externality data was collected ∼6 (LoC at age 10) and 2 (LoC at age 14) years ago. The more recent Japanese data could reflect either a change toward individualism in recent years or that UK culture was less individualist in the early 1990s than it is now. It is not possible to confirm these hypotheses in this study, although there is some recent evidence from a review that modern Japan is a less collectivist society (Takano and Osaka, 2018).

Strengths and Limitations

A major strength of our work is the cross-cultural comparison in two cohorts which have different confounding structures due to cultural and ethnicity differences (see **Supplementary Table B**). We observed little evidence of confounding in either cohort, but residual confounding remains a possibility. Because of the differences in confounding structure across cohorts the similarity of the cross-cohort findings suggests that we can be more confident that residual and unmeasured confounding has not materially affected the findings and that our results are consistent with a causal effect of externality on PLE and DS. Cross-cultural cohort comparisons are also an effective way of investigating the effect of selection bias due to loss to follow up (Richmond et al., 2014), particularly if this varies across cohorts. The pattern of missing data (see **Supplementary Table D**) demonstrates differences in missingness across cohorts but the similarity of the findings suggests that this is not adequately explained by selection bias, further strengthening the inferences that can be made about the causal nature of the observed associations between externality and PLE and DS.

Other strengths of our study include the large sample sizes and the longitudinal nature of the data. The large sample size means we have adequate statistical power to detect relatively small effects, and hence the likelihood that the associations we observe are due to chance is reduced. Furthermore, the prospective study design minimizes the possibility of reverse causation. Another strength is the direct comparison of association strength across cohorts made possible by using the same assessment tools to measure externality and DS and very similar instruments to measure PLE. We also used a statistical test to directly compare the strength of associations between externality and psychopathology, which is rarely reported by other studies.

There are inevitably limitations to our work. ALSPAC and the TTC have suffered from participant attrition, resulting in missing data. Because it is often the participants with more psychological problems that drop out of cohorts, we are likely to have a complete cases sample that is psychologically healthier than those lost to follow up, resulting in selection bias. If those with greater externality are also more likely to drop out, this would likely lead to us under-estimating effects of externality on psychopathology. Previous work carried out in the ALSPAC cohort suggests that using imputed data to account for missingness effects the prevalence but not the strength of associations (Wolke et al., 2009).

We did not have individual measures of individualism or collectivism and there may be considerable individual variation on the individualism-collectivism spectrum within each cohort. There is some evidence that within-cultural variation is larger for collectivist countries that have undergone rapid modernization (Cheng et al., 2011), like Japan. If individual levels of individualism or collectivism are directly related to externality, greater variation on the individualism-collectivism spectrum would change the association between externality and PLE and DS. This problem is also compounded by the fact that in both cohorts the participants were recruited from a specific area of each country. In ALSPAC all participants lived in a small area of the south-west of England, whereas in the TTC all participants

were from 3 regions of Tokyo. It is possible that these regions are not representative of the UK or Japan as a whole and vary in their individualism or collectivism from the rest of the country.

We were not able to directly compare across most ages between the cohorts because of differences in data collection timepoints but we were able to compare more generally between periods of life.

As stated above we were only above to estimate the association between externality and self-reported PLE, rather than more accurate data collected using semi-structured interviews, because only self-report data were collected in both cohorts.

CONCLUSION

Externality was prospectively associated with later reports of both PLE and DS. The strength of the association did not vary by cultural setting suggesting that belief that one lacks agency over negative events may be universally associated with poorer mental health.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/**Supplementary Material**.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by ALSPAC Ethics and Law Committee. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

SS conceived the idea, analyses the data, and wrote the paper. SY, SA, KE, KK, IC, CD, SZ, and AN co-authored the paper and commented on drafts.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.600941/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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