Psychiatry Research ■ (■■■■) ■■■–■■■

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Brief report

The developmental course of childhood inattention symptoms uniquely predicts educational attainment: A 16-year longitudinal study

Jean-Baptiste Pingault [a,b], Sylvana M. Côté [a,b,*], Frank Vitaro [a], Bruno Falissard [b], Christophe Genolini [c,1], Richard E. Tremblay [a,d,e,1]

[a] Research Unit on Children's Psychosocial Maladjustment, University of Montreal and Sainte–Justine Hospital, GRIP, 3050 Edouard–Montpetit Montreal, Quebec, Canada H3T 1J7
[b] INSERM U669, Univ. Paris-Descartes and Paris-Sud, Paris, France
[c] Modal'X, University Paris Ouest–Nanterre–La Défense, Paris, France
[d] Departments of Pediatrics, Psychiatry and Psychology, University of Montreal, Canada
[e] School of Public Health, Physiotherapy and Population Science, University College Dublin, Ireland

ARTICLE INFO

Article history:
Received 1 July 2013
Received in revised form
30 January 2014
Accepted 17 June 2014

Keywords:
Inattention symptoms
Development
Educational attainment

ABSTRACT

In this 16-year longitudinal study, a new trajectory estimation approach was used to verify whether the developmental course of childhood inattention significantly predicted functional impairment. A rising childhood inattention trajectory significantly predicted graduation failure (OR: 1.76 [1.32–2.34]) independently of averaged inattention levels. Rising inattention is, in itself, important for prognosis.

1. Introduction

Childhood attention deficit hyperactivity disorder (ADHD) predicts a number of functional impairments, including long-term low educational attainment through its inattentive dimension (Pingault et al., 2011). Moreover, ADHD symptoms follow different developmental patterns: inattention symptoms remain stable or increase with age, while hyperactivity symptoms tend to decrease (Larsson et al., 2011; Willcutt et al., 2012).

One limitation in the literature is the lack of studies combining these two lines of research to test if developmental patterns of symptoms are accompanied by changes in functional impairment (Willoughby, 2003). In particular, design issues, such as the lack of regularly repeated assessments in follow-up studies (Willoughby, 2003; Langberg et al., 2008), have led to a lack of knowledge concerning the association between developmental patterns of inattention and low educational attainment. In one exception, Breslau et al. (2010) demonstrated that changes in inattention levels between two assessments at ages 6 and 11 were followed by changes in educational achievement between ages 11 and 17.

Developmental trajectories have been used to examine the heterogeneous developmental patterns of inattention symptoms (Willoughby, 2003; Larsson et al., 2011). However, developmental trajectory estimation combines information concerning the level (e.g. high) and the functional form (e.g. rising). As such, we do not know whether children in a high rising inattention trajectory had lower educational attainment because they were in a rising trajectory or simply because they had high mean levels of inattention across childhood. We aimed to test whether averaged levels of inattention across childhood and/or the functional form of childhood trajectories of inattention made a significant contribution to early adulthood low educational attainment. We used a new trajectory estimation approach to reanalyze previously published data (Pingault et al., 2011). Understanding the developmental course of inattention and the associated impairments is a neglected area of study despite potential benefits in terms of basic research – e.g. understanding underlying mechanisms – as well as clinical research – e.g. informing the prognosis (Willoughby, 2003).

2. Methods

2.1. Participants

The study sample included 2000 participants belonging to the Quebec Longitudinal Study of Kindergarten Children and selected to be representative of the children attending kindergarten in

* Corresponding author at: Research Unit on Children's Psychosocial Maladjustment, University of Montreal and Sainte–Justine Hospital, GRIP 3050, Edouard–Montpetit, Montreal, Quebec, Canada H3T 1J7. Tel.: +1 514 343 6963 ; fax: +1 514 343 6962.
E-mail address: sylvana.cote@gmail.com (S.M. Côté).
[1] Genolini and Tremblay shared senior authorship.

http://dx.doi.org/10.1016/j.psychres.2014.06.022
0165-1781/

French-speaking state schools in the province of Quebec in the 1986–87 and 1987–88 school years (Pingault et al., 2011).

2.2. Measures

2.2.1. Outcome variable

Information about high school graduation was obtained through the Quebec Ministry of Education at age 22 and 23. The measure differentiated between participants who had a high school diploma (coded zero) and participants who did not (coded one).

2.2.2. Childhood inattention

Teachers assessed children's behaviors yearly between 6 and 12 years with the Social Behavior Questionnaire. Each item was rated on a 3-point scale (0 to 2) that ranged from "never applies" to "frequently applies" (total range: 0–8). The following four items were used to assess inattention: (1) weak capacity for concentration, cannot maintain his/her attention for a long time on the same task, (2) easily distracted, (3) absentmindedness, and (4) gives up easily (Cronbach's alpha coefficients between 0.85 and 0.90). The Family Socioeconomic Adversity Index included information on family structure (intact or not), parents' education, parents' occupational status and parents' age at birth of the first child (see online supplement).

2.3. Data analysis

We adapted a clustering algorithm designed to estimate non-parametric trajectories: k-means for longitudinal data (Genolini and Falissard, 2010). Briefly, we pre-processed the data for each participant by subtracting his/her average level of inattention across the seven years to each yearly score. As a result, a participant with *high* and *rising* levels of inattention is classified in the same rising trajectory than a participant with *low* and *rising* levels of inattention. Therefore, this new approach clusters participants according to the form of their trajectory excluding information about their mean levels (details in online supplement). Finally, a logistic regression was used to examine the link between trajectory membership and graduation failure, while controlling for inattention levels averaged over the 7 years, sex and family adversity.

3. Results

3.1. Inattention trajectories

Three adjusted trajectories resulted from the analysis: a stable trajectory, a fluctuating trajectory and a rising trajectory (see Fig. 1 and online supplement for details and a rationale regarding the number of trajectories).

3.2. Results

The final model included averaged levels of inattention (mean = 2.26, S.D. = 1.88), trajectory membership, adversity and sex. The averaged levels of inattention across years significantly predicted graduation failure (odds ratio [OR]: 1.78; 95% Confidence Interval [CI]: 1.66–1.91; $p < 0.001$, corresponding to a 1-point increase in average inattention). Children belonging to the rising trajectory were at higher risk of graduation failure (OR: 1.76; 95% CI: 1.32–2.34; $p < 0.001$). Conversely, the fluctuating trajectory was not significant (OR: 1.02; 95% CI: 0.77–1.37; $p = 0.87$). For a more intuitive understanding, we estimated expected percentages of graduation failure in the stable and in the rising trajectory, while holding constant the inattention average and the adversity index at their mean (using bootstrap resampling with 1000 simulations). Graduation failure was higher for boys in the rising trajectory (40.0%) than in the stable one (27.7%); the risk ratio was 1.46 (95% CI: 1.20–1.76). Corresponding results for girls were 27.9%, 18.2% and 1.56 (95% CI: 1.23–1.97).

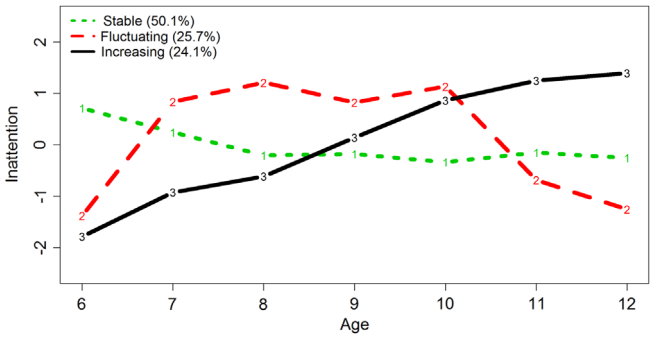

Fig. 1. Adjusted trajectories of inattention from 6 to 12 years old. *Note:* The trajectories will necessarily cross given the prior subtraction of the mean, which also explains the negative scores.

4. Discussion

We aimed to verify whether mean levels of inattention across childhood and/or the form of inattention trajectories made significant contributions to high school graduation failure. Average levels of inattention strongly predicted graduation failure and, independent of these average levels, boys in the rising trajectory were still 46% more likely to fail than boys in the stable trajectory (56% for girls).

The fact that we detected a subgroup of children with rising inattention is coherent with the studies reporting stable or rising inattention levels with age (Larsson et al., 2011; Willcutt et al., 2012) and with the literature reporting a shift towards a greater proportion of the inattentive subtype with age (Willcutt et al., 2012).

Children with rising levels of inattention may have specific genetic and/or environmental liabilities. ADHD symptoms, including inattention, are highly heritable (Larsson et al., 2011). Yet, this does not preclude age-dependent genetic effects i.e. changes in heritability estimates and/or newly developing genetic influences emerging with advancing age (Franke et al., 2012). Environmental changes like transition to middle school may also play a part in these developmental changes (Langberg et al., 2008). Our study demonstrated that these putative liabilities manifested by rising levels of inattention were indeed associated with greater long-term impairment.

Due to the nature of the outcome (official graduation records), only one assessment was available, thus preventing us to model changes in the outcome. However, assessments by a different teacher each year over 7 years were available to monitor the development of inattention.

This study showed that increasing inattention during elementary school matter, even when mean levels of inattention are controlled for, providing evidence for the significance of developmental changes in inattention during elementary school. These results emphasize the need to further characterize the specific predictive value of developmental trends in inattention regarding diverse ADHD-related outcomes. In addition, the role of fixed or time-varying factors (e.g., family events) in explaining these developmental trends, and how such trends can be considered in the assessment of inattention, should be further investigated.

Please cite this article as: Pingault, J.-B., et al., The developmental course of childhood inattention symptoms uniquely predicts educational attainment: A 16-year longitudinal study. Psychiatry Research (2014), http://dx.doi.org/10.1016/j.psychres.2014.06.022

Funding/support

This study was supported by grants from the Fonds québecois de la recherche sur la Société et la Culture; grants from the Social Sciences and Humanities Research Council, Canada; grants from the Canadian Institutes of Health Research (National Health Research and Development Program/Canadian Institutes of Health Research); grant SES-9911370 from the US National Science Foundation; grant RO1 MH65611-01A2 from the US National Institute of Mental Health; and a grant from the National Consortium on Violence Research (supported by grant SBR-9513040 from the National Science Foundation). Dr Genolini received a funding from Agence Nationale de la Recherche, France (IDOL: ANR-12-BSV1-0036). Dr Pingault received a post-doctoral fellowship from the Research Unit on Children's Psychosocial Maladjustment via a grant from the Fonds de la Recherche et de la Santé du Québec Grant number 16031 attributed to Dr. Côté.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.psychres.2014.06.022.

References

Breslau, N., Breslau, J., Peterson, E., Miller, E., Lucia, V.C., Bohnert, K., Nigg, J., 2010. Change in teachers' ratings of attention problems and subsequent change in academic achievement: a prospective analysis. Psychological Medicine 40, 159–166.

Franke, B., Faraone, S.V., Asherson, P., Buitelaar, J., Bau, C.H.D., Ramos-Quiroga, J.A., Mick, E., Grevet, E.H., Johansson, S., Haavik, J., Lesch, K.-P., Cormand, B., Reif, A., 2012. The genetics of attention deficit/hyperactivity disorder in adults, a review. Molecular Psychiatry 17, 960–987.

Genolini, C., Falissard, B., 2010. KmL: K-means for longitudinal data. Computational Statistics 25, 317–328.

Langberg, J.M., Epstein, J.N., Altaye, M., Molina, B.S.G., Arnold, L.E., Vitiello, B., 2008. The transition to middle school is associated with changes in the developmental trajectory of ADHD symptomatology in young adolescents with ADHD. Journal of Clinical Child and Adolescent Psychology 37, 651–663.

Larsson, H., Dilshad, R., Lichtenstein, P., Barker, E.D., 2011. Developmental trajectories of DSM-IV symptoms of attention-deficit/hyperactivity disorder: genetic effects, family risk and associated psychopathology. Journal of Child Psychology and Psychiatry 52, 954–963.

Pingault, J.-B., Tremblay, R.E., Vitaro, F., Carbonneau, R., Genolini, C., Falissard, B., Côté, S.M., 2011. Childhood trajectories of inattention and hyperactivity and prediction of educational attainment in early adulthood: a 16-year longitudinal population-based study. American Journal of Psychiatry 168, 1164–1170.

Willcutt, E.G., Nigg, J.T., Pennington, B.F., Solanto, M.V., Rohde, L.A., Tannock, R., Loo, S.K., Carlson, C.L., McBurnett, K., Lahey, B.B., 2012. Validity of DSM-IV attention deficit/hyperactivity disorder symptom dimensions and subtypes. Journal of Abnormal Psychology 121, 991–1010.

Willoughby, M.T., 2003. Developmental course of ADHD symptomatology during the transition from childhood to adolescence: a review with recommendations. Journal of Child Psychology and Psychiatry 44, 88–106.

Please cite this article as: Pingault, J.-B., et al., The developmental course of childhood inattention symptoms uniquely predicts educational attainment: A 16-year longitudinal study. Psychiatry Research (2014), http://dx.doi.org/10.1016/j.psychres.2014.06.022