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Pre-trauma verbal ability at five years of age and the risk of post-traumatic stress disorder in adult males and females

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ABSTRACT

Previous studies have shown that high cognitive ability, measured in childhood and prior to the experience of traumatic events, is protective of PTSD development. Our aim was to test if the association between pre-trauma verbal ability ascertained at 5 years with DSM-IV lifetime post-traumatic stress disorder (PTSD) at 21 years was subject to effect modification by gender, trauma type or prior behaviour problems. Using a prospective birth cohort of young Australians, we found that both trauma type and behaviour problems did not change the association between cognitive ability and PTSD. During multivariate analysis, testing for the interactive effect of gender revealed that verbal ability was linearly and inversely associated with PTSD in females only, with those in the lowest verbal ability quintile having strongly increased odds of PTSD (OR = 3.89: 95% CI; 1.50, 10.10) compared with those in the highest quintile. A graph of the interaction revealed lower verbal ability placed females, but not males, at an increased risk of PTSD. Our results indicate that lower verbal ability in early childhood is a vulnerability factor for PTSD in females but not in males, and may constitute a gender-specific risk factor responsible for part of the increased risk of PTSD found in females compared with males.

1. Background

Epidemiological research has found an inverse relationship between cognitive ability with morbidity and mortality. Individuals with a lower cognitive ability have an increased risk of a number of conditions in later life including schizophrenia (Zammit et al., 2004), depression, hypertension, lung disease (Der et al., 2009), increased depression persistence and comorbidity (Koenen et al., 2009). However, the mechanisms by which cognitive ability may lead to a decline in individual health outcomes over time remains unclear and intercorrelated with a number of environmental and developmental factors. For this reason, even studies which have conducted extensive cognitive testing prior to the onset of poor health (pre-morbid testing) and controlled for important related affects including socio-economic position (SEP), familial circumstances and indicators of fetal and child development are unable to completely rule out possible residual confounding due to these factors (Batty et al., 2007; Batty et al., 2009; Der et al., 2009).

Despite this, different health outcomes are arguably more or less directly linked to pre-morbid measures of cognitive ability. In this regard, findings from a number of prospective and well-controlled studies of military populations, which suggest a causal link between pre-trauma cognitive ability and Post-Traumatic Stress Disorder (PTSD), appear relatively robust to confounding owing in part to the clearly defined principle determinant of the disorder (combat exposure). This evidence suggests that various measures of pre-combat cognitive ability predict PTSD risk in returned soldiers (Kremen et al., 2007; Macklin et al., 1998; Gilbertson et al., 2006; Marx et al., 2009)

Regarding the mechanism by which lower cognitive ability may result in a greater risk of PTSD, these papers offer multiple explanations owing partly to the variety of neurocognitive performance measures used to predict PTSD. Three studies suggest that higher cognitive ability (Kremen et al., 2007; Macklin et al., 1998) and a high capacity to effectively and flexibly manipulate verbal information (Gilbertson et al., 2006) reduce the negative impact of trauma on the individual by increasing their ability to process and build meaning from their trauma. Another paper suggests that high visual-spatial memory affords the individual an increased capacity in the initial

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acquisition of the visual aspects of the traumatic episode, which aides in rehearsal and later habituation to the trauma (Marx et al., 2009).

While military studies have the advantage of being well-controlled and often use sophisticated testing, participants are typically recruited at the age of enlistment. Although this does not affect the ability of these studies to demonstrate an association between cognitive ability and PTSD, environmental factors and circumstances during childhood and adolescence are unavailable or collected retrospectively. This may result in misspecification during analysis and decreased ability to interpret temporal relationships between cognitive ability and PTSD.

To date, there have been only three prospective, population-based studies that have been able to investigate these life course factors. One study from Storr et al. has found no association between early scholastic ability and PTSD (Storr et al., 2007). The other two studies have found inverse associations between cognitive ability with PTSD risk in late adolescence (Breslau et al., 2006) and early adulthood (Koenen et al., 2007). There were some methodological weaknesses in the studies where associations were found. The first study assessed PTSD when the participants were 17 years of age and yet to pass through the peak period of trauma exposure, affecting generalisability to young adults and also resulting in the identification of very few PTSD cases (Breslau et al., 2006). The second study did not account for trauma type (Koenen et al., 2007). Trauma type is likely to play a confounding role in the relationship between child cognitive ability with PTSD risk, as measures of cognitive and scholastic ability have been found to predict the type of traumas a young person will subsequently experience (Breslau et al., 2006; Storr et al., 2007), and specific types of trauma are highly predictive of PTSD outcomes (Breslau et al., 1999; Brewin et al., 2000; Frans et al., 2005). Additionally, individuals in this study were classed as trauma exposed only if they had experienced an acute reaction to the trauma (criterion A2). This resulted in those who were potentially the most resilient individuals (those who experienced trauma but reported no immediate reaction) being classified as unexposed to trauma (Koenen et al., 2007). A final limitation relevant to both studies was the use of sample sizes too small to permit testing for gender differences. Emerging evidence is showing that gender interacts differently in the relationship between cognition and a range of mental health outcomes. One recent study (Glaser et al., 2011) found that the relationship between cognitive ability and depression in men and women changes over time, especially around puberty, and differs for males and females. Another study (Hatch et al., 2007) found that lower cognitive ability was associated with higher internalizing symptoms in women only. Although neither study assessed PTSD as an outcome, these findings show the need to assess whether the relationship between cognitive ability and PTSD is present only in females, as found previously by these studies in relation to other mental health outcomes.

In this study, we use data from a large prospective birth cohort study to test the hypothesis that verbal ability at 5 years of age according to the Peabody Picture Vocabulary Test-Revised (PPVT-R) is inversely associated with the risk of DSM-IV lifetime PTSD at 21 years of age. We will take into account a range of developmental and environmental characteristics and expand the existing evidence, by testing for the role of gender, trauma type and behaviour problems in the association between verbal ability and PTSD.

2. Materials and methods

2.1. Sample and data

Participants were from the Mater University Study of Pregnancy (MUSP), a prospective birth cohort based in Brisbane, Australia. Between 1981 and 1984 a total of 7223 pregnant mothers were recruited from the Mater Misericordiae Hospital. The first wave of data collection occurred before the birth of the child, after which subsequent data collections were carried out on both mother and child at birth and 6 months, 5, 14 and 21 years after birth. Further information regarding the MUSP has been detailed previously (Keeping et al., 1989; Najman et al., 2005). At 21 years of age, 2547 (35%) of the offspring completed the Composite International Diagnostic Interview (CIDI-Auto) (49% male and 51% female). Of these, 1010 (125 PTSD cases) participants reported trauma exposure and had complete data for multivariable analysis. Informed consent was gained from all participants, all data was coded for confidentiality and ethics was approved for the cohort was approved by the institution and funding body.

2.2. Measurement of verbal ability

The Peabody Picture Vocabulary Test-Revised (PPVT-R) was administered to children at the five year follow-up. The test requires the examinee to indicate which one of four pictures best describes a word which the examiner expresses verbally, with the resulting score used as a measure of the subject's verbal intelligence (Jongsma, 1982). The PPVT-R has been validated against other standardised intelligence tests used on children (Childers et al., 1994; Dunn, 1981; Johnson et al., 1993).

2.3. Measurement of PTSD

At the 21 year follow-up, participants were screened for DSM-IV lifetime Post-Traumatic Stress Disorder (PTSD) (First and Tasman, 2004) using the Composite International Diagnostic Interview (CIDI-Auto) Version 2.1 (World Health Organisation, 1997). The CIDI-Auto was administered by trained interviewers and has been found to have good validity and reliability (Peters et al., 1998). Individuals who experienced one or more of the eleven possible traumatic events were asked further questions regarding the presence of 17 PTSD symptoms from three distinct categories including re-experiencing, hyperarousal and avoidance, in addition to questions assessing the level of functional impairment caused by the symptoms. Importantly, participants needed to have reported an acute reaction to trauma (criteria A2) to be diagnosed with PTSD, but not to be classed as trauma exposed. For participants who experienced multiple traumas, PTSD was assessed with regard to the most 'stressful or upsetting' event. No participants designated combat exposure or being victim of torture or terrorism as their most stressful or upsetting event. We created a four category trauma exposure variable consisting of (1) interpersonal victimisation (rape, molestations, physical assault, threatened with a weapon or kidnapped), (2) interpersonal victimisation and at least one more traumatic exposure (3) non-interpersonal victimisation (accident, witness to death/injury, natural disaster, other) and (4) non-interpersonal victimisation and at least one more traumatic exposure.

2.4. Measurement of confounding factors

Birth weight, maternal age at birth and parity were selected *a priori* to be included in all models due to earlier findings from this cohort reporting an inverse association between birth weight and a number of mental health and behaviour problems (Alati et al., 2007; Alati et al., 2009; Betts et al., 2011) and because of its central role in the proposed mechanism (Gale et al., 2009). We constructed birth weight *z*-scores which were internally adjusted for gender and gestational age as a crude measure of fetal development. Birth weight and gestational age (in weeks) were taken