



Coordination difficulty and internalizing symptoms in adults: A twin/sibling study



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ABSTRACT

Increased anxiety and depression symptoms have been reported in individuals with neurodevelopmental disorders, and have been found to be associated with motor coordination difficulties, but little is known about the etiology of these associations. This study aimed to assess genetic, shared (making twins/siblings alike) and non-shared (individual-specific) environmental influences on the association between poor coordination and symptoms of anxiety and depressed mood using a sample of adult twin and sibling pairs. Participants were asked about their coordination skill and anxiety and depression symptoms. About half of the variance in coordination difficulty was explained by familial (combined genetic and shared environmental) influences, with the remaining variance explained by non-shared environmental influences. Phenotypic associations between coordination and anxiety ($r=.46$) and depression symptoms ($r=.44$) were largely underpinned by shared familial liability for the three traits. Non-shared environment accounted for about a third of the phenotypic association. Results suggest that both familial and non-shared environmental influences play a role in the etiology of coordination difficulty and its association with internalizing symptoms. The current study highlights that both biological and environmental pathways shared between these symptoms should be examined in future research to inform prevention and treatment approaches in clinical settings.

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1. Introduction

Motor coordination difficulties are associated with a number of neurodevelopmental disorders, including autism spectrum disorder (ASD) (Bhat et al., 2011), attention deficit-hyperactivity disorder (ADHD) (Pitcher et al., 2003) and dyslexia (Fawcett and Nicolson, 1995), and are central to the diagnostic criteria for developmental coordination disorder (DCD) (American Psychiatric Association, 2013). Poor motor skills early in life predict later anxiety and depression symptoms, suggesting that coordination difficulties might be a developmental risk factor for internalizing problems (Piek et al., 2010; Sigurdsson et al., 2002). Indeed, symptoms of anxiety and depression are often reported in children and adults with DCD (Hill and Brown, 2013; Kirby et al., 2013; Pratt and Hill, 2011) and are associated with lower life satisfaction (Hill et al., 2011; Kirby et al., 2013). Furthermore, general coordination

difficulties have been reported in children with anxiety and depression (Ekornas et al., 2010; Emck et al., 2011; Skirbekk et al., 2012). However, although there is evidence for an association between coordination difficulties and anxiety and depression symptoms across the lifespan, little is known about the role of genetic and environmental influences on these associations. Furthermore, while the links between coordination difficulty and anxiety and depression are becoming clearer in children and adolescents, there is sparse literature focusing on adults.

The current study aimed to assess a number of influences on self-reported coordination difficulty, and the association between coordination difficulties and symptoms of anxiety and depression, using a sample of adult twin and sibling pairs: genetic (A), shared environmental (those making individuals within a family more alike: C) and non-shared environmental (those making family members less similar: E) were considered. Understanding the role of genetic and environmental factors involved in poor coordination might be important for the future identification of individuals 'at-risk' of developing motor difficulties. To date, genetically-informative studies have examined the etiology of DCD/coordination in childhood and adolescence only. Specifically, one study

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compared the similarity of siblings on parent- and teacher-reported motor problems, and identified moderate familial influences (combined genetic and shared environmental influences: $F=.22$ and $.47$, for parent- and teacher-report respectively) on motor problems in children (Fliers et al., 2009). Furthermore, two previous twin studies (Martin et al., 2006; Moruzzi et al., 2010) found moderate to high genetic influences ($A=.44-.69$) on coordination difficulties in childhood and adolescence, with the remaining variance explained by non-shared environmental influences. To our knowledge, no study to date has estimated genetic and environmental influences on coordination difficulties in adults. Given that genetic influences on psychopathological traits tend to increase with age (Bergen et al., 2007), it is possible that the heritability of coordination problems might be even higher in adults.

Next, the current study aimed to add to the emerging literature concerning the association between emotional and coordination difficulties in adults, moving away from a focus on the prevalence of anxiety and depression symptoms in these individuals to an improved understanding of the etiology of these psychological outcomes. Understanding the overlap between coordination difficulty and symptoms of anxiety and depression may provide opportunities for targeted interventions for these emotional problems in individuals with DCD or other motor disorders, which might otherwise be overlooked when focusing on the core diagnostic criteria for these disorders. This could improve the quality of life of individuals with coordination difficulties by providing them with strategies for dealing with increased symptoms of anxiety and depressed mood, which may otherwise interfere with their daily functioning and employment opportunities. It has been suggested that symptoms of depression may be associated with unemployment amongst those with DCD (Kirby et al., 2013). As mental health issues are one of the biggest causes of absences from work across Europe (World Health Organization, 2010), understanding the underlying causes of such problems are important for society, as well as for those who experience these traits.

There is an ongoing debate in the literature regarding the reasons for the co-occurrence of coordination difficulties and internalizing symptoms. The “environmental stress hypothesis” put forward by Cairney et al. (2010) suggests that DCD/poor coordination could lead directly to an increase in internalizing symptoms through the disruption of a child’s typical social activities, including taking part in team sports and games, and by lowering self-worth and self-concept through repeated failures to complete seemingly simple motor tasks, and comparison with peers whose motor skills are superior (Cairney et al., 2013). In line with this view, a previous study with children and adolescents suggested that within monozygotic twin pairs, the twin who had a motor disorder had higher levels of parent-reported depression than their co-twin who did not have a motor disorder (Piek et al., 2007). This finding suggests an environmental contribution to the association between coordination difficulty and depression. Furthermore, another study from the same research group found that twins who were discordant for a motor disorder had higher levels of parent-reported anxiety than those in concordant twin pairs (Pearsall-Jones et al., 2011). The authors suggest that the association between motor and anxiety symptoms can in part be explained by non-shared environmental influences; affected individuals in discordant twin sets are able to directly compare their motor ability and performance with a twin who has no coordination difficulties, whereas concordant twin pairs do not have this immediate social comparison (Pearsall-Jones et al., 2011).

To our knowledge only one twin study (comparing monozygotic and dizygotic twin pairs) to date has examined the association between coordination difficulties and anxiety symptoms (Moruzzi et al., 2010). The study investigated a range of emotional

and behavioral problems, as well as physical ‘clumsiness’ (or motor difficulties), in children and adolescents, using the parent-report Child Behavior Checklist 6–18 (Achenbach et al., 2003). Of the different DSM-oriented scales completed, only anxiety and ADHD problems were independently correlated with clumsiness. Twin modelling analyses revealed that genetic factors explained more than half of the phenotypic association between clumsiness and anxiety, with the remaining variance explained by shared and non-shared environmental influences. Furthermore, using co-twin design, the study was able to show that the association between clumsiness and anxiety was due to genetic and environmental covariation rather than direct causal effects. Taken together, the studies using genetically-sensitive designs suggest that both genetic and environmental influences may play a role in the co-occurrence of coordination problems and internalizing symptoms in children and adolescents.

The current study aimed to elucidate the role of genetic, shared and non-shared environmental influences in self-reported coordination difficulty, anxiety and depression in a sample of adult monozygotic and dizygotic twins, as well as sibling pairs. These data will be highly valuable in the study of self-reported coordination difficulties, in which there are few studies of internalizing symptoms in adults, and could be relevant to understanding the shared etiology of coordination difficulty, anxiety and depression in this population. In line with previous studies in young people, we hypothesised that adult coordination problems would be moderately heritable in adults. Furthermore, in line with previous epidemiological evidence we expected that self-reported coordination problems and anxiety and depression symptoms would co-occur in our sample, and that this association would be largely underpinned by genetic influences, as suggested by the one previous twin study with children and adolescents. Finally, given that the genetic influences on anxiety and depression significantly overlap in adults, including in our sample (Kendler et al., 1992; Waszczuk et al., 2014), we hypothesised that there might be a single set of genetic influences common to coordination problems, anxiety and depression.

2. Method

2.1. Participants

The analyses use data from wave 5 of a longitudinal twin and sibling study, the Genesis 12–19 (G1219) as this is the only wave at which coordination difficulties have been assessed. Full recruitment and sample characteristics details are provided elsewhere (Barclay et al., In prep.; McAdams et al., 2013). Ethical approval for wave 5 data collection was provided by Goldsmiths Research Ethics Committee, University of London. Written informed consent was obtained from all participants. The sample size and zygosity is presented in Table 1. The mean age was 25.30 years ($SD=1.81$, range=22–32 years) and 66% of the sample were female. Parental education level in the G1219 participants was slightly higher than the general population, with 39% educated to A-level or above compared to 32% in the nationally representative sample (Meltzer et al., 2000). Parents from the G1219 sample were also more likely to own their own homes (82% compared to 68% in the nationally representative sample).

2.2. Measures

Coordination difficulty was measured by asking participants to report how uncoordinated they felt: ‘not at all’, ‘a little’, ‘somewhat’ or ‘very’ uncoordinated. Score frequency is presented in Table 1. Anxiety was measured using the Revised Symptoms of

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