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# An investigation of cognitive overlap in working memory profiles in children with developmental disorders

Tracy Packiam Alloway*, Tahir Seed, Furtuna Tewolde

*Department of Psychology, University of North Florida, 1 UNF Drive, Jacksonville, FL 32224, USA*

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ABSTRACT

We investigated the nature of cognitive independence or overlap between working memory and IQ in the following developmental disorder groups: Autism Spectrum Disorder (ASD), Intellectual Disability (ID), and Speech and Language Impairment (SLI). Participants were tested on standardized measures of IQ and working memory. The data indicates that there was some cognitive overlap in visuo-spatial working memory and nonverbal IQ. All three developmental disorder groups were distinguished by their severity of deficits: the SLI group performed in the normal range; the ASD group had scores in low-average range, and ID group scored below average. These findings correspond with evidence that developmental disorders do not have single, independent cognitive deficit. Clinical and educational support should be tailored accordingly.

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## 1. Introduction

A multiple cognitive deficit model is becoming an increasingly common way of understanding developmental disorders. This model explains the connections between comorbidities amongst developmental disorders by proposing that the causes of these symptoms are multifactorial across multiple risk and protective elements. These risk factors overlap amongst different developmental disorders, and express themselves in comorbid symptoms. (Pennington, 2006). Developmental disorders that are either behaviourally defined, such as Autism Spectrum Disorder (ASD), or cognitively defined, like Intellectual Disability (ID) and Speech and Language Impairment (SLI) exemplify this etiological mosaic. Rather than comprising of independent components, they can have overlapping risk factors that interact within each developmental pathway. Understanding the nature of this relationship is crucial to how we conceptualize these disorders, as well as develop targeted support. One issue of interest is the extent of symptom independence or overlap with respect to two related cognitive skills – working memory and IQ – in the following groups: Autism Spectrum Disorder (ASD), Intellectual Disability (ID), and Speech and Language Impairment (SLI).

Working memory refers to a system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning (Baddeley, 1996). This view of working memory has evolved over time from the concept of a unitary short-term memory system into a multi-component storage and processing unit that deals with higher order cognitive function controlling many of the behaviours related to learning (Alloway, Gathercole, Willis, & Adams 2004; Baddeley, 2000). Working memory is typically assessed using tasks that require the individual to store and process information. We will discuss how aspects of working memory deficits can function as risk

* Corresponding author at: Department of Psychology, University of North Florida, 1 UNF Drive, Jacksonville, FL 32224, USA.
*E-mail address:* t.alloway@unf.edu (T.P. Alloway).

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factors that lead to the expression of overlapping cognitive symptoms amongst the aforementioned groups of developmental disorders.

There are two differing views of the relationship between working memory and IQ. On the one hand, there is substantial evidence that working memory and fluid intelligence share neural substrates, such as the prefrontal and parietal cortices (Gray, Chabirs, & Braver, 2003). On the other hand, although working memory shares psychometric properties with IQ, it is dissociable (Alloway, 2010; Cain, Oakhill, & Bryant, 2004). For example, one meta-analysis suggested that working memory and general fluid intelligence (Gf) share on average 20% of their variance, which suggests that these two constructs are not synonymous (Ackerman, Beier, & Boyle, 2005).

Looking at working memory specifically, verbal and visuo-spatial storage structures are functionally separable to a certain degree as early as age 11, and fully separable in adulthood, while processing appears to be domain-general (Alloway, Gathercole, & Pickering, 2006). While working memory has shown less overlap with Gf, it may be that specific structures of working memory, such as verbal and visuo-spatial storage, show a stronger association.

Research on children with developmental disorders is mixed regarding the relationship between IQ and working memory. In studies of students with intellectual disabilities, low IQ scores are often accompanied with low working memory scores, presenting a consistent pattern of deficits in both cognitive skills (Alloway, 2010; Henry, 2001). Similarly in students on the autistic spectrum, their working memory scores appear to correspond with IQ levels—in low functioning students, working memory is impaired (Russell, Jarrold, & Henry, 1996; Griffith, Pennington, Wehner, & Rogers, 1999), while in high functioning ASD students, no working memory deficits were reported (Alloway, Archibald, & Rajendran, 2008). However, in studies of children with SLI, they are characterized by nonverbal IQ scores in the typical range, but poor verbal working memory (Alloway, 2010; Henry, 2001; Archibald & Gathercole, 2006).

Given these mixed findings on the relationship between working and IQ in different learning disability populations, the aim of the present study is to investigate this issue within the context of the multiple cognitive deficit model. The discussion of multiple deficits (in this case, cognitive risk factors) in developmental disorders is usually confounded by the issue of comorbidity (Angold, Costello, & Erkanli, 1990). Thus, in the present study, the aim was to recruit children that did not present additional learning difficulties. Participants were tested on standardized measures of IQ and working memory in order to investigate the issue of cognitive overlap.

## 2. Method

### *2.1. Participants*

Ninety-six English-speaking children participated in this investigation with the following breakdown across groups: 26 children with Autistic Spectrum Disorder (ASD); 32 children with Intellectual Disabilities (ID); 15 children with Specific Language Impairment (SLI); and 23 children with typical development (TD). All children were recruited from middle income homes. Ethical approval for the project was granted by the university ethics committee, and parental consent was obtained.

#### *2.1.1. Autism Spectrum Disorder (ASD) sample*

The group with ASD had a mean chronological age of 8.4 years (SD = 36 months; range = 49–161 months) and consisted of 23 boys and 3 girls. All children with ASD were attending special units within the mainstream schools and had received a confirmed diagnosis of Autism Spectrum Disorder from a multi-disciplinary team that included a psychologist, speech and language therapist, occupational therapist and/or child & adolescent psychiatrist. The ASD diagnosis was carried out using Autism Diagnostic Observation Schedule (ADOS) and The Diagnostic Instrument for Social and Communication Disorders (DISCO). The diagnosis also included a clinical evaluation of the child following ICD-10/DSM-IV criterion. The exclusion criterion was any additional diagnosis such as Attention Deficit Hyperactivity, and other co-morbid diagnosis.

#### *2.1.2. Intellectual Disability (ID) Sample*

The group with ID had a mean chronological age of 9.75 years (SD = 36 months; range = 56–192 months) and consisted of 21 boys and 11 girls who were either attending special schools or mainstream schools. All children with ID received a standard score of 80 or less on the Full Scale IQ using the Wechsler Intelligence Scale for Children (Wechsler, 2003) or the Wechsler Primary Pre-school Scale of Intelligence (Wechsler, 2002) for children under 6 years of age. Children with a diagnosis of ADHD or any other known medical condition were excluded from the study.

#### *2.1.3. Speech and Language Impairment (SLI) Sample*

The group with SLI had a mean chronological age of 8.2 years (SD = 26 months; range = 73–154 months) and consisted of 10 boys and 5 girls. They were recruited from a community speech and language department and were attending the special and language classes especially designed for children with language difficulties. These children are referred to the special unit on the basis of their specific difficulties with speech and language. The criterion for selection is that these children performed not less than 1.5 standard deviations in the Perceptual Reasoning and Processing Speed indices of the Wechsler Intelligence Scale for Children (Wechsler, 2003) and received standard scores of less than 70 in the Clinical Evaluation of Language Fundamentals Test (Elisabeth & Eleanor, 2006). Children were excluded from the study if they had an additional diagnosis of ADHD, ASD, or motor coordination disorder.