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Cognitive profile of young well-trained athletes with intellectual disabilities

Debbie Van Biesen[a,*], Jennifer Mactavish[b], Katina McCulloch[a], Laetitia Lenaerts[a], Yves C. Vanlandewijck[a]

[a] KU Leuven, Faculty of Kinesiology and Rehabilitation Sciences, Department of Rehabilitation Sciences, Belgium
[b] Yeates School of Graduate Studies, Ryerson University, Toronto, Canada

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ABSTRACT

Background: Previous research has shown that cognitive and motor skills are related. The precise impact of cognitive impairment on sport proficiency, however, is unknown.
Aims: This study investigated group and individual differences in cognitive profiles in a large cohort of track and field athletes, basketball players, swimmers and table tennis players with (N = 468) and without (N = 162) intellectual disabilities (ID).
Methods and procedures: Based on the Cattell-Horn-Carroll Theory of Cognitive abilities, eight subtests were selected for inclusion in a generic cognitive test (GCT) to assess executive functions and cognitive abilities relevant to sport, i.e., fluid reasoning, visual processing, reaction and decision speed, short-term memory and processing speed.
Outcomes and results: Reliability coefficients for the subtests ranged between 0.25 and 0.88 respectively. Factor analysis revealed two clusters of subtests, i.e., a speed-based factor (simple and complex reaction time and simple and complex visual search) and a performance-based factor (Corsi Memory, Tower of London, WASI Block Design and Matrix Reasoning).

After controlling for psychomotor speed, the group of ID-athletes scored significantly lower than athletes without ID on all the GCT subtests, except the complex visual search test. When cognitive profiles of individual ID- athletes were examined, some obtained higher scores than the average norm values in the reference population.
Conclusions and implications: The GCT is currently administered as part of the classification process for athletes with ID who compete in the Paralympic Games. The results of this study indicate that the complex visual search and Tower of London test in the GCT should be reconsidered.

What this paper adds?

The outcome of this study has generated new insights about the relationship between cognitive abilities and sport by spanning the boundaries of distinct research areas to produce a new body of knowledge. These insights offer the potential for resolving a primary research challenge in 21st century Paralympic sport, which is to develop evidence-based systems of

* Corresponding author at: KU Leuven, Faculty of Kinesiology and Rehabilitation Sciences, Department of Rehabilitation Sciences, Tervuursevest 101, 3001 Leuven, Belgium.
E-mail address: debbie.vanbiesen@faber.kuleuven.be (D. Van Biesen).

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eligibility and classification that address the impact of impairment on sport proficiency (Tweedy & Vanlandewijck, 2009). In this context, the outcomes of the present study have had a direct and positive effect by enabling the reinclusion of elite ID-athletes the world over, in a limited number of Paralympic sports. For ID-athletes, dedicated to intense training and elite performance goals, having the right to participate in Paralympic Games is highly important.

The cognitive test described in this study is currently being used as one component of the process for enabling ID-athletes to participate in events sanctioned by the International Paralympic Committee (IPC). Inclusion of these athletes in the Paralympic Games has provoked escalating media interest which is an important mechanism for advancing awareness of the strengths and talents of these athletes and, in turn, enhancing positive attitudes towards people with disability and diversity in general.

1. Introduction

In an equal society having a disability should not be a barrier to enjoy physical activity or to excel in sport. The Paralympics Games is recognized today as the pinnacle in sporting excellence for those with a large range of disabilities (Jobling, 2012). Intellectual impairment is one group of eligible impairments that has recently been re-included in the Paralympics, but only in a limited number of sports (Kwon & Block, 2012). In order for these athletes to compete at the most elite level, evidence-based sport-specific classification systems that clearly denote the impact of impairment on performance (Tweedy & Vanlandewijck, 2009) needed to be developed. Similar to the example of a single below the elbow amputation, which has a greater affect in swimming than in marathon running, one would expect an intellectual impairment to have less affect in physically demanding events (e.g., 100 m sprint) than in those with heavy cognitive demands (e.g., decision making, pacing). The available literature (Burns, 2015), however, offers no straightforward conclusions that could substantiate these assumptions. There is a paucity of previous work in this area and, as such, a lack of clarity about the underlying principles and explanatory mechanisms for understanding the relationship between cognition and proficiency in sport. Multiple studies have highlighted the relationship between cognitive abilities and sport performance (Kasahara, Mashiko, & Niwa, 2008; Kioumourtzoglou, Derri, Tzetzis, & Theodorakis, 1998; Mann, Williams, Ward, & Janelle, 2007) but the precise nature of this relationship remains unclear. Elite athletes are found to perform significantly better than novices in various aspects of intellectual functioning, including visual-spatial awareness, memory, and response speed and accuracy (Mann et al., 2007). A recent systematic review by Van der Fels et al. (2014) showed, among young children, a strong linkage between cognitive skills and motor skills with the highest cognitive demand, i.e., fine motor skills, bilateral body coordination, and timed performance in movements. The motor tasks with limited or no connection to cognitive skills required the least amount of cognitive engagement in the tasks (e.g., strength). From a neuropsychological view, these novel findings are consistent with the notion that motor and cognitive skill functioning is mediated by the co-activation of the cerebellum (important for complex and coordinated movements) and the prefrontal cortex (important for higher-order cognitive skills). Van der Fels et al. also found evidence of a correlation between motor skills and higher-order complex cognitive skills such as fluid reasoning and visual processing. In recommendations for future research, these authors noted that to better understand the relationship between cognitive and motor skills requires moving beyond reliance on general IQ measures by focusing on relevant categories of motor and cognitive skills, which is the approach adopted in the present study.

The Cattell-Horn-Carroll (CHC, Schneider & McGrew, 2012) theory of cognitive abilities is widely accepted by researchers interested in intelligence as a common nomenclature and theoretical framework for examining various aspects of human cognitive abilities. We use the CHC taxonomy as the theoretical framework for conceptualizing cognitive abilities with a focus on assessing those essential for optimal sport proficiency.

According to CHC theory, there are 10 broad cognitive abilities, ranging from Gf (Fluid reasoning or the deliberate but flexible control of attention to solve novel problems that cannot be performed by relying exclusively on previously learned habits) to Gt (Reaction and decision speed, or the speed of making very simple decisions or judgments when items are presented one at a time). For the complete and detailed overview of the theory and all components we refer to McGrew (2009). From the total set of broad cognitive abilities as laid out in the CHC taxonomy five abilities with major relevance to sport performance were identified (i.e., fluid reasoning, short-term memory, processing speed, reaction and decision speed and visual processing) and this set of cognitive abilities was assessed by means of corresponding subtests. From a neuropsychological viewpoint it also was relevant to include a subtest to account for executive functions, as these are the basis for many cognitive abilities (Ardila, Pineda, & Rosselli, 2000). Further support for this approach comes from the work of Vestberg, Gustafson, Maurex, Ingvar, and Petrovic (2012) who showed that executive functioning has potential as a predictor of success in sport.

The main purpose of the present study was to examine differences and similarities in the cognitive profiles of young well-trained athletes from a wide range of sports (i.e., athletics, swimming, table tennis and basketball). To fully understand the relationship between sports proficiency and cognition this study included individuals with and without intellectual impairments, with a primary focus on elite athletes with intellectual disabilities (ID-athletes). To clarify the terminology we use, Paralympic systems of athlete classification, as described in the International Paralympic Committee's (IPC) classification code (IPC, 2007) is based on the language and concepts articulated in the *International Classification of Functioning, Disability and Health* (ICF) model. According to the ICF model, disability is an umbrella term used to describe the inter-relationship between impairment, activity limitations and participation restrictions; impairment as a stand-alone term describes a deficit in body function or structure. To be consistent with the IPC Classification code, throughout the remainder of the text, the