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The impact of intellectual disabilities on elite sports performance

Jan Burns, Canterbury Christ Church University

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Abstract

Athletes with intellectual disabilities (ID) were re-introduced into the Paralympics in London 2012. As part of this development a classification system had to be established evidencing the impact this impairment has on elite sports performance. This review examines the research behind this issue. Firstly it examines the limited literature comparing the standards reached by top-level athletes with ID with those without disabilities, and then moves on to look at the research demonstrating differences in both the cognitive and physical skills needed for elite performance. The paper then reviews the factors which may be implicated to account for this disparity, from a range of perspectives. A case is made for the importance of looking at this area in terms of the potential for the transferability of research findings from this group to talent identification in mainstream athletes and the benefits of integrating neuropsychological concepts and approaches to understanding the cognitive components behind the development of particular skills associated with high level performance in specific sports.

Keywords: Intellectual disabilities, Paralympics, elite performance, cognitive functioning

Context

The place of sport and exercise in the lives of people with intellectual disabilities (ID) has attracted much research in recent years. Much of this has focused on sport and exercise as remedial or preventative activity to combat specific health issues such as obesity and poor physical health. Other research has looked more at the psychosocial impact of improving social networks (Hutzler & Korsensky, 2010) or psychological factors such as increasing self-esteem (Weiss, Diamond, Demark, & Lovald, 2003). However, leading up to and beyond the re-introduction of athletes with ID into the London Paralympics in 2012 there has been an increasing interest in the participation of these athletes in elite competition, and it is this work which will form the focus of this review.

The word 'Olympics' and people with ID have a long association through the Special Olympics. The Special Olympics was originally set up in the US in the late 1960's with the aim to provide training and competition for children and adults with intellectual disabilities. These days it caters to 4.2 million people across the world and includes a programme of unified (disabled and non-disabled) sport. However, within the Special Olympics, although highly successful and bringing benefit to millions of people with ID and their families across the globe, the emphasis is more on participation, empowerment and opportunity than achieving elite performance (Specialolympics.org, 2015). This domain is the remit of another organisation, the International Federation for Para-athletes with Intellectual Disability (INAS).

The vision of INAS is *"….inspired by a belief that an intellectual disability should not be a barrier to enjoying and being the best in sport. INAS' vision is that athletes with an intellectual disability across the World have the opportunity to achieve excellence in sport and high-level competition." (www.INAS.org*)

INAS has about 4,000 registered athletes from over 50 countries, across the globe, competing in ten summer and two winter Paralympic sports. This federation works closely with the

International Paralympic Committee (IPC) to promote and develop high level competition for athletes with ID, organising its own international world championships in specific sports and a Global Games, attracting over a 1,000 athletes. It has also worked closely with the IPC to address the issues which led to athletes with ID being excluded from Paralympic competition after the Sydney 2000 Paralympics. This was a consequence of the purposeful inclusion of members of a basketball team not having ID, who then went on to win the competition. The whistle was blown by a journalist within that team and there was a subsequent enquiry by the IPC leading to the team being stripped of the gold medal and the eligibility governance procedures being heavily criticised (Kwon & Block, 2012). This impairment group was then excluded from Paralympic competition until more reliable strategies were in place to ensure that athletes have the required impairment of intellectual disabilities.

By 2009 such strategies had been implemented, but by that time Paralympic classification had moved on and there was now a requirement that every impairment group had an evidence based classification system that demonstrated the impact of that specific impairment on that specific sport, and a way of classifying athletes according to severity of impact, so that competition was based on skill, training and effort and not level of disability (Tweedy & Vanlandewijck, 2011). This raised an interesting question in terms of what evidence is available to demonstrate the impact of ID on high level performance and also resulted in a research programme sponsored by the IPC and INAS to try and answer this question to enable the development of a classification system, and re-gain entry to the Paralympics. Whilst research into this question continues, sufficient research was carried out in athletics, swimming and table tennis to develop a classification system for these events and subsequently athletes with ID were re-included in the Paralympic schedule, with 118 such athletes competing in London 2012.

The purpose of this review is to look at the research behind this decision, specifically, to investigate what research can tell us about the impact of ID on achieving elite levels of sport performance. This is an emerging field so available literature is limited, but what is evolving does have important contributions to make in terms of the role intellectual factors play in elite sports performance. Firstly, the question of definitions will be addressed as this is often the first point of contention. Then the performance of elite athletes with ID will be compared to those without disabilities. Research which has looked at what might account for these differences will then be examined, followed by a consideration of how these factors may be related to intellectual functioning. The review will conclude with some of the challenges facing researchers in this area, but will also highlight the potential gains for further research on this topic both for athletes with ID and talent identification generally.

Definitions and Epidemiology

Intellectual disabilities is a social construct; the terminology used differs in different nations (e.g. learning disabilities in the UK, mental retardation previously in the US); it is culturally dependent; diagnostic criteria have changed over time; prevalence rates vary over the developmental life span, and aetiology is unknown for potentially over half the population (Emerson, Hatton, Dickson, Gone, & Caine, 2012). Nevertheless it is clear that ID exists, it is prevalent across every culture in the world and is linked to some very well founded genetic causes, with well evidenced accompanying features e.g. Downs Syndrome. As such when trying to research the impact of this phenomenon defining the population presents some challenges.

One of the most commonly used definitions is that of the American Association on Intellectual and Developmental Disabilities (AAIDD):

'*Intellectual disability is characterized by significant limitations both in intellectual functioning and in adaptive behaviour as expressed in conceptual, social, and practical adaptive skills. This disability originates before age 18*.' (Schalock et al., 2010, p5).

The diagnosis is described as having three elements (Shalock, 2010): 1) significant limitation in intellectual functioning usually measured by an IQ test with a cut-off point being taken at approximately two standard deviations below the mean, (70-75); 2) significant limitation in adaptive functioning, usually measured by a scale such as the Vineland (Sparrow, Cicchetti, & Balla, 1989) covering social, conceptual and practical domains; 3) age of onset, usually taken as under 18, to discriminate between acquired impairment, when through normal development skills will have been acquired and then lost, resulting in different rehabilitation trajectories. It is not difficult to see that with the arguments attached to IQ measurement, the environmental and cultural dependence of adaptive behaviour, and the somewhat arbitrary ending of intellectual development at age 18, that diagnosis is not clear cut.

Prevalence rates vary according to the level of intellectual disability, gender, urban versus rural environments, social conventions such as the use of pre-natal screening, marriage traditions, social-class, and income of the country. Based on a review by Hatton (2012) using long-standing data prevalence is reported as around 3-4 per 1,000 for those with more severe ID and 3.7-5.9 per 1000 for milder ID. In a meta-analysis of prevalence rates from 52 studies (Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2011) quote a higher general figure of 10.37/1000 and give a comprehensive review of factors affecting prevalence. The higher prevalence rate cited compared to the earlier studies reviewed by Hatton (2012) may be related to the increase of studies included from less economically wealthy regions and possibly wider inclusion criteria. From such studies it is clear there tends to be more people with mild ID compared to severe and more boys than girls (Hatton, 2012).

Aetiology of ID is linked to events which occur at the prenatal, perinatal and postnatal stages, which may be bio-medically linked such as chromosomal disorders including Downs Syndrome, or due to infections such as meningitis or linked to environmental events such as foetal alcohol syndrome or birth trauma. It is clear that the causes of ID may be multiple for over 50% of the population and for a large majority unknown. Estimates of unknown aetiology are 20-40% for those with severe disabilities and rising to 45-62% for those with mild disabilities (for a review see Hatton, 2012). Associated physical disorders are common, the most likely being epilepsy (15-30%), cerebral palsy and motor disorders (20-30%), sensory and visual (10-20%) (Fishbach & Hull, 1982). Mental health and behavioural issues in later years have also been recognised as highly associated (20-40%), but it is less clear if these are associated with the primary consequence of the impairment or secondary to trying to live in society with these disabilities (Hatton et al, 2012). There is evidence that the more highly impaired intellectually the higher the incidence of associated disorders (McLaren & Bryson, 1987)

From a consideration of the constellation of impairments implicated in ID it seems probable that having an ID will impact on elite sports performance, however this requires further exploration and it is important to clearly map the relationship between ID and sports performance, as not all people with ID have additional impairments. If we strip away the confounding issues of co-morbid physical, sensory and mental health disorders and secondary consequences such as environmental poverty we are left with trying to understand how intellectual factors impact on sports performance. Investigating those with impaired intellectual functioning also illuminates possible implications for the relationship between intellectual functioning and performance for athletes without disabilities. Hence, it is important to firstly establish if there is a difference between high level performance of athletes with ID and those without, before we consider why this might be.

To complete this review a literature search was carried out using online databases PsychInfo, Medline, and Sport Discuss. Combinations and alternatives of the following search terms were used; intellectual disabilities, elite, Paralympic, sport, cognitive, IQ, performance, impairment, and athlete. As the focus of the review is specifically on the evidence relating to the impact of the intellectual impairments which are central to the definition of a diagnosis and not the potential accompanying physical/sensory disabilities, publications which related just to those aspects and not the cognitive aspects were screened out. Other papers which related to training or other interventions and made no comparative assessment of cognitive functioning were also screened out, as were those not relating to elite sport, leaving a total of 10 papers for inclusion in this part of the review. The literature search reaped 102 papers which were then hand searched to ensure all relevant papers had been included, and matching against the inclusion/exclusion criteria to exclude irrelevant papers. This resulted in the inclusion of one additional paper and reduction of identified papers to a total of 10 papers. A data extraction form was developed to describe the participants, focus, comparison sample and results, loosely based on the PICO approach (Sayers, 2008). In terms of evaluation of the quality of the evidence the principles described in the EPPI Centre guidance for conducting systematic reviews were used (EPPI, 2010). The review and evaluation was conducted by the sole author.

Comparison of ID and non-ID sport performance at an elite level

To date there has only been one published study which has looked specifically at comparing elite ID sports performance competition standards with those who do not have impairments. Other studies, largely related to the ID Paralympic classification programme, have been more focussed on the technical aspects of sports performance and proficiency. Tilinger (2013)compared the athletic achievements across a number of events for the highest level of ID competition results (INAS world records) against those of the International Association of Athletics Federations (IAAF) and the Czech national sports Association for the Mentally Handicapped (ČSMPS). Across all 19 athletic events the difference between INAS and IAAF results was substantially lower for athletes with intellectual disabilities, ranging from 8.2% - 45.3%. There was a progression of scale of difference across the types of events, which was consistent between men and women. The smallest differences were in sprint, progressing to middle distance events, endurance races, jumping events, with the greatest difference shown in throwing events. For example, in 100m sprint for men the world IAAF record was 9.58 sec and for INAS 10.68 (+11.5 %),and for women in shot put 22.63m in IAAF and 14.33m in INAS (+38.5%). Comparison with the IAAF results from ČSMPS showed consistent but even more dramatic differences. Such results suggest that even at the pinnacle of ID sport performance, the gap between world level performance is large, and the implication is that this margin increases the more technical or cognitively demanding the event becomes.

From the experience of those in the field and through the conceptual model of Paralympic classification accepted by the IPC (Tweedy & Vanlandewijck, 2009), in addition to published and unpublished evidence, as above, there is an acceptance that the presence of ID does have an effect on sports performance such that the standards reached by those without ID cannot usually be attained. Other studies have compared specific aspects of sports performance between athletes with ID and high performing athletes without ID within individual sports, but not compared competition results. Such research attempts to chart how ID may impact to reduce sports performance. This research will now be reviewed in relation to each sport where there are relevant publications.

Athletics

Only one published study to date has compared athletic performance between ID and non-ID within a specific athletic discipline, which is a study of sprinters carried out by Andrews, Goosey-Tolfrey, & Bressan (2009). This is an interesting study because sprinting is considered a 'closed' skill, i.e. performed in a relatively controlled environment, stable and predictable, and implicates only a small set of prescribed cognitive skills, compared to an 'open' skill such as a football which is less predictable and requires a wider range of cognitive skills. Hence, of all events it might be predicted that the presence of primary ID will have least impact, if any, on sprinting. Andrews et al (2009) compared ID sprinters at the 2006 INAS world games to non-intellectually disabled university level sprinters on stride frequency and length, and the related variables velocity and acceleration using an accepted video analysis approach to studying sprint kinematics.

Clear differences were found between the two groups showing ID sprinters took slower and shorter strides, resulting in both their velocity and acceleration being significantly reduced compared to their peers. In addition, there was much more variability of stride length across different phases of the sprint compared to the non-ID group. Why this difference may occur is discussed in a later section, but this study provides some evidence that even in a closed, low cognitive load event, ID have a detrimental influence.

Swimming

There are a number of studies in this area which were drawn upon to develop the IPC classification methods for Paralympic competition. In the Daly, Einarsson, Van, & Vanlandewijck (2006) study video data was compared between 100m freestyle ID swimmers (S14) in the 2000 Sydney Paralympics and the 2004 INAS Global Games World Championships with those with visual (S13 and S12) and loco-motor (S10 and S9) impairments, and non-disabled swimmers from the 2000 Sydney Olympic Games, 2000 Australian Olympic trials, 2005 European indoor championships and the 2005 Scandinavian youth championships. The variables measured were 'Clean speed' (CSS) (i.e. not involving turns), Stroke Rate (SR) and Stroke Length (SL). Overall, they found little difference on these measures between the groups, although there was a trend towards a lower stroke rate for ID individuals, but this did not seem to impact on speed. However, they did not report overall comparison of race performance.

In another study Einarsson (2009), used video analysis to compare the in-competition performance of eight ID and eight non-ID 200m swimmers on a range of indices. They found no difference on many of the measurements, but did find that the non-disabled group were faster, even though they had more women in the group (5 compared to 3) and that performance was also less variable in this group. Comparing points accrued over different competitions the non-disabled group tended to accrue more points suggesting that their performance grew by a greater margin. Results also showed that the impact of executing a turn had a greater impact on performance for the ID swimmers than the non-disabled, especially in terms of the proficiency of the turning action. Limitations were pointed to in terms of the validity of some measures and it was acknowledged that with some indices lower performance may be due to more limited race opportunities.

In the only study to date on elite swimmers with Downs Syndrome, Marques-Aleixo et al., (2013) examined the basic movement characteristics in 16 world class swimmers with DS performing front crawl. They specifically examined intracyclic velocity variations (IVV) which is an indicator of swimming efficiency and the Index of Coordination (IdC), a measure of the temporal synchronization between the arms, giving a measure of the swimmers' ability to coordinate movements and maximise propulsion. In addition they examined breathing patterns which contribute to overall performance. Their findings showed that both IVV and IdC were different for DS swimmers compared to both experienced and non-experienced non-DS swimmers, and negatively affected both drag and propulsion, to a greater extent than might be expected from just lack of training. These problems were further exacerbated by the breathing patterns of the DS swimmer, especially on the non-preferred side.

Table tennis

Table tennis is the sport in which most research has occurred comparing high level competitive athletes with ID against non-disabled competitors, the majority of which has come out of the University of Leuven group contributing to the development of a Paralympic classification system. Table tennis was chosen to investigate as it is fast paced, cognitively demanding and has sufficient, highly competitive ID players. So far there have been five published studies which have directly compared various aspects of the table tennis playing capabilities of experienced ID players with those without ID.

The first study specifically examined the relationship of ID to the tactical skills involved in returning serve, which requires the integration of motor, cognitive, perceptual, and psychological skills (Van Biesen et al., 2010). The study compared 39 male ID players competing at the 2005 World Championships with eight non-disabled national level male players. Proficiency was measured across 16 sets of 15 identical serves using a table tennis robot, with the instruction that the athlete had to return to a specified target (A4 size) on the return side of the table. Each block of serves differed in terms of either, stroke (forehand/backhand), direction (cross/straight), spin (top, right, left, back) and the field of play, but was consistent in time between serves. Adaptation was measured by the number of returned services hitting the target and accuracy was measured in terms of both Absolute Error (AR) i.e. how far from the centre of the target the return was and Relative Error (RE) which measured the direction of error. Analysis was carried out through video analysis using Dartfish software. In addition, a measure of reaction time and speed of upper body movement was administered as it had previously been shown that these skills are implicated in table tennis performance.

The results showed that the players with ID were able to adapt their return in relation to spin and that the learning profile was similar to non-disabled players, but they did not reach the same level of proficiency. ID players were also found to be substantially less accurate than the comparison group, and tended to take more time to correct systematic errors. Greater variation in the amount of error relating to different spins was also recorded. The ID players also had significantly lower reaction and upper body speed than the comparison group.

This study was followed by a study looking at tactical proficiency using the service return but improving the ecological validity of the simulation by replacing the robot with a human opponent (Van Biesen, Mactavish, Pattyn, & Vanlandewijck, 2012). The participants included 41 male and 30 female table tennis players with ID competing at the World Games in 2009. The comparison group was 12 males and five females with a similar length of training history who competed in youth or regional level competitions. The testing protocol was similar to that used in the previous study (Van Beisen et al 2010) but this time service was delivered by either a male or female expert player of similar experience who remained constant across the same sex opponents. The player was not asked to hit a target but to try and 'win each rally' and an expert rated the tactical proficiency. Players were asked to engage in a series of 12 rallies with five services, which included six service variations delivered in a set sequence. The results replicated the first study in that the general performance of players with ID was lower than the non-disabled group. Players with ID improved their score across the five serves, but though lower (range 3.00-3.3) was not significantly different than the comparison group (range 4.3-5.2). As hypothesised no relationship between IQ scores and tactical proficiency was found.

A further study turned attention to the assessment of technical proficiency in table tennis players with ID by assessing the players' ability to implement a variety of strokes (Van Biesen, Mactavish, & Vanlandewijck, 2013). Here a larger sample was employed which included 71 table tennis players with ID (41 males, 30 female) competing in the 2009 World Championships with the same comparison group of 17 (12 male, five females) players without ID competing at the youth or regional level in their countries. A standardised test-battery was developed which involved the player being asked to play 10 different sets of 10 identical strokes in return to a ball delivered by a table tennis robot, the serves varying in a systematic way. A reliable technical observation protocol was developed through collaboration with experts and each return was rated against this protocol resulting in a technical proficiency score. As hypothesised the players with ID scored significantly lower than the comparison group. This was examined in more detail by a more thorough analysis of the top eight players with ID. They too scored significantly lower, but the margin was less and again technical performance was not related to IQ. Across the whole sample technical proficiency differed in relation to the difficulty level of the stroke and there was substantial variation between ID players.

There are limitations to these studies. The first issue relates to the comparison sample of non-disabled players, which is small and not matched in gender, age or level of competition to the target sample. Choosing an appropriate comparison in terms of competition level is challenging as matching athletes competing in world level events would be inappropriate due to the large differences in training and competitions opportunities, regardless of the pragmatic challenges of obtaining such data. Matching in terms of training history is an adequate compromise but could have been strengthened by a better matched, larger sample size, however it is important to note that even against younger, possibly less experienced players the athletes with ID scored significantly lower. The other limitation noted by the authors is the artificial nature of making such judgements based outside of actual competition, when many more competition and psychological factors come into play. Hence, in the next study (Van Biesen, Mactavish, & Vanlandewijck, 2014a) studied how simulation testing compared to actual game play. In this study the top 24 male (N=13) and female (N=11) players at the 2009 World tennis Championships completed the simulation testing as described in the previous paper. This was then compared to their actual game play through video analysis and the technical proficiency rated through the previously developed scoring protocol. Ratings of overall technical proficiency were not significantly different between the two conditions, but an examination of the individual strokes showed a strong to moderate positive relationship for only three of the eight possible measured strokes. However, in the game situation not all the strokes were displayed by the players with ID making comparison difficult. It may have been the case that these players resorted to using only those skills which they felt they had mastery over in the game situation. In addition within the simulation condition there was more opportunity to prepare and predict, whereas in the context of competition the requirement to respond spontaneously is greater, leading to a reduction in technical proficiency and execution for more technically demanding strokes.

The latest study attempted to take this analysis one step further by looking at the relationship between different types of sports intelligence and the tactical proficiency of table tennis players with ID (Van Biesen, Mactavish, & Vanlandewijck, 2014b). A direct linear relationship between IQ and sports performance might not be expected, different types of cognitive abilities have been implicated in the execution of high level sports skills or proficiency (e.g. Ward & Williams, 2003, Voss et al, 2010). Although research into this area is still limited, a model of 'generic and sports specific intelligence' has been used as a basis to build a programme of research upon which the current IPC classification system for athletes with ID has been built. This study is part of that programme of work and examines the linkage between generic sports intelligence and tactical proficiency in table tennis players with ID. The hypothesis was that from a range of types of intelligence linked to sport performance some will be associated more with tactical proficiency and therefore impact on sport specific performance.

A total of 112 table tennis players with ID who competed at INAS Global, National or European championships were included in the study. The ID sample mean IQ was 59.9. For the IPC classification research nine standardised, well validated, neuropsychological tests had been brought together into one package, administered by a touch screen computer or through table top tests. These included tests of visual perception and speed, visual-motor abilities, memory and learning, fluid intelligence, processing speed and executive functioning. The tests were administered by trained administrators according to a standardised protocol, with guidelines for scoring and interpretation.

The contribution of the different types of sports intelligence on the outcome variable of tactical proficiency was investigated using multiple regression. Simple reaction time and block design (spatial visualisation ability) were found to predict tactical proficiency. It is perhaps not surprising that reaction time is linked to high level table tennis performance, however, as Van Biesen et al (2014b) point out research linking specific, neuro cognitively defined, cognitive skills to sports performance is limited. For example, at this point only one published study exists which as looked specifically at visual special abilities as measured by block design (a routine assessment in neuropsychology), which showed very promising results in terms of talent identification (Kasahara, Mashiko, & Niwa, 2008). What is interesting is that Kasahara et al's (2008) study linked this visual spatial ability to high level performance in team play, whereas Van Biesen's et al's (2014b) study demonstrated the link within an individual sport. What is also interesting is that the measure of executive functioning was not implicated in predicting performance, as previous research has demonstrated this link in mainstream sports (e.g. Vestberg, Gustafson, Maurex, Ingvar, & Petrovic, 2012; Jacobson & Matthaeus, 2014). Such a finding might suggest that executive functioning might only come into play over a certain level of performance or that there may be methodological issues attached to how it is measured, drawing on either a neuropsychological or a sports background.

It is likely over the next few years that as the INAS/IPC Paralympic classification research programme continues that more research will be published examining the link between ID and specific types of sports intelligence, which offers a potentially rich seam of work in term of talent identification. Whilst this research will be based on athletes with ID the conceptual framework has applicability to the general population and a database of comparative populations without ID will also be developed. From the data gathered so far it is clear that there are consistent findings that ID does appear to have a deleterious impact on performance across a range of different sports, and this does not seem to be a consequence of different levels of training, although environmental consequences such as competition opportunities may add to that impact. This individual difference has been found across 'closed' sports where the environment is relatively stable and the cognitive load is not high (sprinting), to other more 'open', cognitively demanding sports (table tennis). As has previously been predicted (Ackerman, 2014; Coward & Sackett, 1990) no direct linear relationship with IQ has been found, but specific cognitive skills have been implicated in superior performance for specific sports.

Having established that ID does appear to impact on sports performance and proficiency it is important to consider why this might occur. To do this a framework of describing the elements of sports proficiency is helpful, and one found to be useful in this arena by Van Biesen, et al (2012) is that of Williams, & Reilly (2000). Here the core predictors of talent are deemed to be physical, physiological, psychological/perceptual-cognitive skills, and sociological.

Physical predictors

This includes anthropometric and biomechanical considerations such as height, limb girth, body fat etc. As stated earlier given the aetiology of ID it is clear that for many the physical conformation of individuals with ID may differ from those without, especially for those whose aetiology is attached to chromosomal differences. For example, people with Down's syndrome tend to be short of stature, have a wide gait, muscle hypotonicity and hypermobility of the joints. There is a wealth of literature in this area, however the majority of it does not relate to elite performance athletes with ID. The existence of co-morbid physical factors rules out many athletes with ID from competing at an elite level and it is the small percentage of individuals with recognised ID, for whom there is no clear aetiology, who do not have accompanying physical conditions who come through to elite sports competition. However, there is some evidence that even in elite level sport for people with ID there may be some physical differences. For example, Andrews et al (2009), in their study of sprinters showed that those athletes with ID were on average 4cm shorter than the comparison group, which may impact by up to 5cm in terms of stride length, and Van Biesen et al (2010) found differences in speed of upper limb. Other, but possibly commonly unrecognised, specific physical performance factors implicated in sports performance have also been shown to differ in this population, specifically balance and manual dexterity. Lahtinen et al (2007) in a 30 year follow up study showed differences in balance and manual dexterity and that there was an association with IQ, with balance problems increasing the lower the IQ. Postural balance, manual dexterity and muscle strength differences have subsequently been demonstrated in a variety of studies and the association with IQ levels replicated (e.g. Blomqvist, Olsson, Wallin, Wester, & Rehn, 2013; Franciosi, Baldari, Gallotta, Emerenziani, & Guidetti, 2010; Vuijk, Hartman, Scherder, & Visscher, 2010).

Physiological and fitness factors

Physiological factors, including aerobic and anaerobic measurements are well established indicators of potential sport talent. Some of these factors may be associated with physical differences and hence there is a link with the higher incidence of physiological differences in athletes with ID. For example, the anthropometric, cardiac and respiratory differences in athletes with Downs syndrome results in lower maximal oxygen uptake (VO2max) than both the average population and those with other types of ID (Seron & Greguol, 2014).

Other studies of young people and adults with ID have consistently shown negative differences in general fitness and specifically, cardiovascular endurance, muscular strength, endurance, and range of motion (Hartman, Smith, Westendorp, & Visscher, 2014; Salaun, & Berthouze-Aranda, 2012; Cuesta-Vargas, Paz-Lourido, & Rodriguez, 2011; Zhang, Piwowar, & Reilly, 2009; Faison-Hodge & Porretta, 2004). This has been related to general levels of physical activity being lower in this population, however when considering the potential to attain high standards of physical fitness a more mixed picture emerges. Van de Vliet et al., (2006) used the EUROFIT battery to examine the physical fitness of 313 INAS elite athletes with ID compared to a sample of physical education students. The athletes with ID were heavier (but 95% within the normal range), more flexible, had higher upper body muscle endurance, similar abdominal muscle endurance, could run as fast, but had lower speed of limb movement, explosive strength and handgrip strength. Cardiovascular endurance was also significantly lower than the physical education students. None of the participants had DS. This study demonstrated that in some areas, with training individuals with ID can reach comparable levels of fitness to the general and sportive populations, but that some differences still remained. Further research needs to take place to understand the lower performance in limb speed movement, physical strength and cardiovascular performance, which may be a consequence of training history or may be a naturally occurring limiting factor associated with ID, similar to the balance issues mentioned earlier.

Psychological

Psychological factors cover a broad range of issues and in their model William and Reilly (2000) discriminate between three categories, personality (traits and states), cognitive factors and game intelligence.

Personality (traits and states)

As Williams and Reilly (2000) recognise research in this area is yet to produce clear and consistent relationships between individual's overall psychological profiles and success in sport. Echoing this, to date, there have been no specific studies examining traits investigated in the general sports literature such as mental toughness in samples of athletes with ID. More work has occurred in relation to the more transient states such as motivation to participate in sport for athletes with ID. Hutzler & Korsensky, (2010) reviewed 23 studies in a comprehensive systematic review of motivational correlates of physical activity for people with ID. They concluded that motivation to participate in exercise and sport was related to both intrinsic (having fun) and extrinsic (winning medals) motivation, however how this compares to the mainstream literature was not examined. It must be recognised that when considering the states and traits of people with ID participating in sport the high base rate of psychological problems experienced by this group will have a significant impact. The high prevalence of low self-esteem, depression, anxiety disorders and other clinical problems have been well documented in this population (Hatton, 2012). Indeed, as with other vulnerable groups sport and exercise has been promoted as an effective prophylactic and intervention to prevent and reduce such psychological problems (see the reviews of Bartlo & Klein, 2011; Johnson, 2009; Frey, 2004; Lancioni & O'Reilly, 1998)

Cognitive

Within sports performance Williams and Reilly (2000) highlight the development of research on the relationship between specific cognitive skills and talent identification as representing one of the most promising and exciting areas of development. Hence, the transferability of knowledge gained from examining the impact of ID on sports related cognitive factors holds much potential. The research underpinning the development of Paralympic classification for athletes with ID underpins the work which is currently being published in this area. Through a distillation of existing literature and models of intelligence a generic cognitive test battery has been developed to look at the impact of specific type so sports intelligence on performance. Visual spatial skills and simple reaction time have been found to discriminate between athletes with and without ID (Van-Biesen, 2010) and within the mainstream literature a number of discrete cognitive skills are also showing evidence of being able to discriminate between experienced and less experienced players (e.g. memory (Williams, Donovan, & Dodge, 2000), reaction time (Brooks, Boleach, & Mayhew, 1987), visual spatial abilities (Kasahara, (2008)). Both this work with athletes with ID and with mainstream athletes suggest that specific types of cognitive profiles may be implicated in the high level performance of sports, and the isolation of specific types of cognitive skills may be linked to the tactical and technical abilities required in different sports.

Game intelligence

Williams and Reilly (2000) refer briefly to 'game intelligence' which they describe as 'analytic, creative and practical skills'. From a neuropsychological perspective this could be seen as an umbrella term similar to meta-cognition, including self-regulation and executive functioning. Mainstream research is showing that the presence of such skills can discriminate talented from non-talented players in a variety of sports, football, (Toering, Elferink-Gemser, Jordet, & Visscher, 2009), hockey and gymnastics (Robazza, Pellizzari, & Hanin, 2004), boxing (Khani, Farokhi, Shalchi, Angoori, & Ansari, 2011), basketball (Cleary & Zimmerman, 2001) and athletics (Williams et al., 2000). Given that such cognitive skills have been shown to be often underdeveloped in people with ID it makes sense that they would have a deleterious impact on sports performance. This will be the case especially for those sports which are highly cognitively demanding such as team sports. Self-regulation is also important as this commands the regulation of lower order of cognitive skills such as attention, which may already be compromised. Hence, for a sport like table tennis where the ability to attend to the right stimuli and then shift attention effectively is highly important, therefore having low abilities in these areas will have a significant impact on performance. Such differences in self-regulation may also account for the higher variability found in athletes with ID when performing specific sports skills which require standard repetition.

Sociological[1]

Here Williams and Reilly (2000) include family influences and facilities, practice and the role of the coach. In terms of considering factors affecting achieving peak performance for athletes with ID it is important to consider even wider issues, including, economic, political and cultural. Even in an economically wealthy country such as the UK Emerson and Hatton, (2007) suggest that poverty or low socio-economic status accounts for between 20-50% of the increased risk for poorer health and mental health amongst British children and adolescents with ID. Educational and social welfare support for individuals varies considerably across the globe, but overall they tend to receive poorer support and suffer more challenging circumstances than many minority groups within society (World Health Organization, 2011). The recognition and impact on the family unit of a member having ID can be both positive and negative, but in circumstances where the family are already struggling this impact tends to be more negative (Lunsky, Tint, Robinson, Gordeyko, & Ouellette-Kuntz, 2014). Hence, the circumstances under which an individual is supported and given the opportunity within their family to participate in sport may not be the same as for others. It is clear that the trajectory for those with ID is likely to be more challenging and impoverished from those without and lack of exposure to positive learning experiences, especially during critical developmental periods will impact on later learning. That this then might impact on the development of expertise such as elite sports performance is not a large leap of logic.

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[1] Williams and Reilly (2010) use the term 'sociological' but this might be better interpreted as social and socio-economic factors.

Adapted physical education and coaching has made many advances in the last decade, however, the focus tends to be more on physical and sensory disabilities and less so on ID, with coaches reporting the need for more specialist knowledge to be developed (Luiselli, 2012). In addition, with the exclusion of athletes with ID from the Paralympics up until 2012 investment in sport for this group faded and the opportunities for national and international competition was reduced. Given this wider social context it can clearly be seen that many obstacles still lie in the path of the athlete with ID who may have the physical and psychological talent to be an elite performer.

Conclusion

It is clear as (Ackerman, 2014) states:

'Development of expert/elite performance skills is most likely a complex function of cognitive, affective, and conative[2] *traits that in turn determine the direction, intensity, duration, and effectiveness of practice/learning' p11*

This is in addition to an individual's genetic endowment, health status and developmental opportunities. Given that ID affects all of these it should be no surprise that having ID will impact and limit sport performance such that for the very rare exceptions performance will not match the elite performance of athletes without intellectual disabilities. From the literature reviewed we may conclude that there is a difference in outcome of elite performance for those with and without ID, and some evidence that this occurs even in low 'cognitive load' sports. This difference can be demonstrated through the tactical, technical and physical components of sports performance. Taking a cognitive component approach to expert sports performance reaction time and spatial visual skills are implicated. However, experience is also implicated as although improvement through practice occurs this may be at a slower rate for athletes with ID and performance more variable than those without, which may have add-on impact should they be competing in an exclusively ID as

[2] Conative in this context referring to the aspect of mental processes which relates to action e.g. impulse, volition, as distinct from cognition and affect.

opposed to inclusive or mixed contexts. Nevertheless, in accounting for this difference there is a complex interplay between cognitive, physical, affective, environmental and developmental processes, and careful consideration must be given to the potential and actual contribution and interaction of each.

Areas for future research

Voss et al (2010) describes two approaches to studying sport and cognition, a) the expert performance approach, which studies the athlete in the context of sports performance and b) the cognitive component skills approach, which focusses on measuring discrete cognitive skills which tap into the intrinsic cognitive demands of the sport. Examining what occurs when such cognitive skills may be impaired is central to researching the impact of ID and elite sports performance, and foundations have been established using both approaches. To build on this work further research needs to be carried out on other implicated cognitive processes such as attentional cueing (shift), visual discrimination, inhibition and attentional breadth, as all these areas have been shown in a meta-analytic review carried out by Voss et al (2010) to be implicated in superior sports performance. All are linked to the meta-cognitive functions of executive functioning and self-regulation, and may account for some of the challenges shown by players with ID in terms of slower learning trajectories and inconsistency of performance. Taking a broader social-cognitive perspective, given the considerable overlap between a diagnosis of ID and Autism (Hatton et al, 2012), a striking omission is research on 'theory of mind', especially in relation to individual versus team sports performance.

In terms of a cautionary methodological issue, athletes with ID and no co-morbid disabilities are not representative of the clinical population, hence when studying sport and people with ID the intellectual components should be considered alongside careful monitoring of additional physical or sensory disabilities. Nevertheless, research directed at understanding how ID impacts on expert sports performance opens up opportunities to improve the standards attained for both those with and those without ID, and opens a new area for researchers from a range of disciplines to apply their analytic skills.

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