Development and validation of the Wheelchair Imagery Ability Questionnaire (WIAQ) for use in wheelchair sports

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Authors note: This paper was written conforming to *Psychology of Sport and Exercise's* language policy and a person first approach to disability language. The term *athletes with a disability* (AWD) was used to refer to athletes who have a physical impairment and who compete in their respective para sports. The term *able-bodied athlete* is used to infer an athlete who does not have a disclosed physical impairment and therefore does not meet the inclusion criteria for participation in para sport. A copy of the Wheelchair Imagery Ability Questionnaire (WIAQ) and the associated scoring system, is available on request from the corresponding author.

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Abstract

Objectives: Appropriate tools to measure psychological skills in wheelchair athletes seldom exist within the sport psychology literature. Given the benefits of imagery on performance, and the lack of an appropriate wheelchair specific measure, the aim of this multi-study research programme was to develop a new psychometric tool to measure the vividness of movement imagery in wheelchair athletes. We used the Vividness of Movement Imagery Questionnaire – 2 (VMIQ-2; Roberts, Callow, Hardy, Markland & Bringer, 2008) as a conceptual framework for item creation and subsequent development of a new tool known as the Wheelchair Imagery Ability Questionnaire (WIAQ).

Method: Study 1 focused on item creation for the WIAQ for the scale with a purposeful sample of wheelchair athletes using focus groups. Study 2 tested the factor structure of the WIAQ using a Bayesian Structural Equation Modelling (BSEM) approach. Study 3 provided concurrent validity of the WIAQ.

Results: Study 1 resulted in the development of the initial 24 item WIAQ. Study 2 refined the scale through the use of BSEM to a 15 item measure. Study 3 provided support for the WIAQ evidence for the concurrent validity of the measure.

Conclusion: The WIAQ is the first known measure specifically created to measure imagery ability in wheelchair athletes and has scope to be used in a broader rehabilitation context for individuals and practitioners making use of imagery as a tool to support various physical recovery strategies.

Keywords: Imagery, vividness, disability sport, scale development, applied sport psychology, rehabilitation.

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Following the success of the Rio 2016 and London 2012 Paralympic Games, there has been an increased interest in the sporting performance and participation of athletes with a disability, with the Paralympic movement and the associated body of research growing (Brittain, 2016; Misener & Darcy, 2014). Recently, at the Rio Paralympic Games 2016, it was reported that 4328 athletes with a disability (AWD) from 159 countries (plus, for the first time ever, an Independent Paralympic Athletes team featuring refugee athletes) competed in 528 events in 22 different sports (www.paralympic.org). The Rio games was the second largest Paralympic games in history, second only to London (www.paralympic.org). However, despite this increased interest and attention, there is still relatively little known about the factors influencing the development of AWD (see Dehghansai, Lemez Wattie & Baker, 2017). Indeed, although psychology specific research in disability sport is growing and has expanded into areas such as stress and coping (Campbell & Jones, 1997), motivation (Wu & Williams, 2001), athletic identity (Huang & Brittain, 2006), reasons for engaging in para sport (Garci & Mandich, 2005), posttraumatic growth (Day, 2013), the role of para-sport in the construction of disabled and athletic identities (Peers, 2012), activist identities in disability sport (Smith, Bundon & Best, 2016) and use of psychological skills training (de Bressy de Guast, Golby, Van Wersch, & d'Arripe-Longueville, 2013), much is still to be understood.

Recent commentaries (e.g., Martin & Malone, 2013) highlight that relative to able bodied athletes, very little is known about the psychological processes underlying the performance of AWD, and what research does exist, has mainly been conducted with non-elite athletes and often involves comparisons to able-bodied sport athletes rather than focusing exclusively on the performance and specific issues faced by AWD. Arnold, Wagstaff, Steadman, & Pratt

(2017) recently offered a refreshing investigation into the organisational stressors encountered by AWD revealing, somewhat unsurprisingly, that AWD encountered similar stressors to those of able-bodied athletes. However, of more interest was that the AWD disclosed a range of distinct, disability specific stressors that were reported to impact on their sporting performance. These included, but were not limited to, issues with inaccessible venues, lack of disability specific coaching and training opportunities, lack of crowds at disability events and the disability classification system. Additionally, Arnold et al. (2017) supported the claims of others (e.g., Dieffenbach & Statler, 2012) indicating that despite an interest in sport psychology support, lack of access to a psychologist is a further stressor for AWD. Arnold et al. (2017) made a call for service providers and psychologists to consider creative ways to support AWD and develop and implement "appropriate and impactful, evidence based stress management interventions" (p.1195).

In an attempt to answer Arnold et al.'s (2017) call, the current paper shares a series of studies focusing on the use of imagery in AWD. Within able-bodied sport and applied sport psychology, the use of imagery as a vehicle for improving performance is a well-established and researched topic (for reviews, see Cumming & Williams, 2012; Malouin, Richards, Jackson, Lafleur & Doyon, 2007). For example, it is well established that individuals who have the ability to imagine their movements accurately, vividly and with ease demonstrate greater improvements in their performance compared to those who struggle to use imagery (e.g., Robin et al., 2007). Furthermore, imagery is a popular mental technique used by coaches and athletes with the intention of enhancing self-regulation of thoughts, feelings and behaviors in successful elite athletes (Cumming & Williams, 2013). Within disability sport research, there is some useful but limited evidence specifically focusing on the benefits of imagery use in adapted water-skiing (De Bressy et al., 2013) and wheelchair rugby (Martin & Malone, 2013). Martin and Malone (2013) investigated the use of imagery (and self-talk) and indicated that wheelchair rugby players make use of both cognitive (e.g., skill learning) and motivational (e.g., increase effort) forms of imagery. Despite these studies recognising that AWD are able to make use of basic psychological skills including imagery, little is known about AWD use of imagery and ability to image given a lack of relevant psychometric measures available. The omission of suitable imagery ability tools is an important factor for consideration for researchers and practitioners interested in imagery use in AWD. If practitioners are to support AWD effective use of imagery, then there is a requirement to understand how well these athletes can image.

If AWD are to be included in sport psychology support and interventions, then practitioners and researchers need to consider the appropriateness of the measures available to assess mental skills. This is important if appropriate interventions are to be designed and implemented for this population of athlete. De Bressy de Guast et al. (2013) focused on imagery use in wheelchair water-skiing and stated that if the aim is to improve the performance of a particular movement then athletes with disabilities need to imagine themselves in a real competitive situation and this includes visualising the chair that they perform in. This point is further supported by Hanrahan (1995) and later by Szameitat, Shen and Sterr (2007) who stated that for wheelchair athletes, the chair needs to be a part of the image being created as it is a necessary piece of equipment just as any other piece of equipment needs to be part of the visualization process for athletes without disabilities (such as a tennis racket or a golf club) and must be both familiar and physically possible to execute by the wheelchair athlete. Previous research has attempted to make some basic, initial adaptations to existing but predominately "able bodied centric" psychometrics. Shearer, Mellalieu, Shearer & Roderique-Davies (2009) identified that the original Vividness of Movement Imagery Questionnaire (VMIQ; Isaac, Marks & Russell, 1986) was designed for able-bodied athletes, in other words those who have functional capacity in all limbs. As such, some of the items would not be relevant to those who do not have lower limb function (e.g., Spina Bifida, Spinal Cord Injury, Polio). Through the use of focus groups, Shearer et al. (2009) adapted the VMIQ items for use in their study of wheelchair basketball players by simply replacing items that requested participants to imagine lower body movements with upper body ones – a simple and effective adaptation but the adapted items had not been subjected to any measurement validation analysis and therefore may not be reliable or valid for use beyond the scope of the context they were used in. Shearer et al. (2009) indicated that few modified assessment tools are available and that there is a need for the development of these for future practice as well as more guidelines for working with athletes with disabilities.

As not to dismiss the existing measures that could be used with AWD, there are a number that *could* be deemed suitable to measure the broad construct of imagery ability but each have their own limitations and issues for consideration. These include the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011), which focuses on athletes use of strategy and planning for their performance so is useful however no physical movements are alluded to in the measure. Another measure is the Kinaesthetic and Visual Imagery Questionnaire-20 (KVIQ-20; Malouin et al., 2007) which has been used more widely in the rehabilitation setting. The KVIQ-20, and a shortened 10 item version, was developed to be used in participants with sensorimotor impairments and in particular has been evaluated in patients after stroke, those with a lower limb amputation, those with acquired blindness and Parkinson's disease (Page, Levine & Leonard, 2005; Malouin et al., 2007; Shuster, Lussi, Writh & Ettlin, 2012). Most of the movements required of the participants in the KVIQ-20 are static movements so do not require the individuals to imagine themselves travelling / moving which would be common place in athletes. Within a sporting context, the most popular measures available are the Movement Imagery Questionnaire-3 (Williams et al., 2012) and Vividness of Movement Imagery Questionnaire-2 (Roberts et al., 2008) both of which are drawn from the able-bodied literature and are focused on functional everyday dynamic movements. However, many of the items make reference to movements that a wheelchair user could struggle to physically execute (e.g., "stand with both feet shoulder width apart" and "imagine yourself running upstairs") and these are therefore limited in their current unmodified versions.

Imagery ability is often assessed via vividness of an image, the ease of image creation or a combination of the two. Ease and vividness are highly correlated (Williams & Cumming, 2011) and in an attempt to create a new measure that focuses specifically on measuring imagery ability in wheelchair sport users we needed a conceptual framework to guide the creation and development of the new measure. Given its credibility and popularity, and its use in a wide range of disciplines such as sport psychology, cognitive psychology and neuroscience (e.g., Callow & Roberts, 2010; Jiang, Edwards, Mullins, & Callow, 2015) this framework was based on the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts et al., 2008). The VMIQ-2 is a development of the original VMIQ (Isaacs et al., 1986) and is a well-established and utilized measure of imagery ability that measures three aspects of imagery: imaging movements looking out through one's own eyes (Internal visual imagery, IVI), imaging watching oneself perform a movement (External visual imagery, EVI) and imaging the feel of a movement (Kinesthetic imagery, KI), comprising 12 movements for each subscale, resulting in 36 items in total. Movements include whole body movements such as "running upstairs" and "jumping off a high wall". Each is rated on a 5 point Likert scale ranging between 1 (*Perfectly clear and as vivid as normal vision or movement*) to 5 (*No image at all, you only "know" you are thinking of the skill*). While the VMIQ-2 demonstrates appropriate psychometric properties, and has also received support of its validity from a neural perspective (see Jiang et al., 2015) on close inspection, it is evident that the VMIQ-2 is wholly unsuitable for use with a wheelchair population (sporting or otherwise). For example, 10 out of the 12 movements are highly difficult or physically impossible for a wheelchair user to execute. These items include walking, running, kicking a stone, running upstairs, jumping sideways, kicking a ball in the air, running downhill, riding a bike, swinging on a rope and jumping off a high wall. Due to the unsuitability of the measure it is evident that new items needed to be created and a measure specifically designed for wheelchair sports athletes.

In an attempt to address these highlighted limitations, the aim of this research was to develop and establish validity for a newly created measure of imagery ability designed primarily with wheelchair sport athletes in mind, hereafter referred to as the Wheelchair Imagery Ability Questionnaire (WIAQ). In order to achieve these aims, three studies were conducted. Study 1 formed the basis for creating the items of the WIAQ through the use of focus groups with elite wheelchair basketball athletes. Study 2 examined the factor structure of the WIAQ through Bayesian structural modelling (BSEM). Finally, to establish further validity for this measure Study 3 examined the newly created WIAQ with other validated imagery measures.

Study 1 – Development of the WIAQ

The aim of this study was to create a pool of items to assess imagery vividness in wheelchair athletes in order to form of a new measure, the Wheelchair Imagery Ability Questionnaire (WIAQ). Given there are no pre-existing measures specifically aimed at wheelchair sport athletes, the VMIQ-2 was used as a conceptual framework to guide the creation of the new items.

Method

Participants

A purposefully selected sample of six elite female wheelchair athletes (*Mean age* = 25.17, *SD* = 2.83) were invited to take part in two focus groups, consisting of three athletes in each focus group. All participants were national level wheelchair basketball players with a range of years' experience in the sport (*M* = 8.83, *SD* = 2.66), and international experience (*M* = 6.33, *SD* = 2.5), with all representing their country in at least one Paralympic Games. All participants provided consent to take part in the focus group. The participants had a variety of different physical impairments including spinal cord injuries, motor neuropathy, proximal focal femoral deficiency and Cerebral Palsy. There was a combination of both congenital (4) and acquired conditions (2).

Measures

Vividness of Movement Imagery Questionnaire–2 (VMIQ-2; Roberts et al. 2008*)*. Participants were provided with a copy of the original VMIQ-2 as a framework and structural guide for basing discussions on and to help with the creation of the new items for the WIAQ. The VMIQ-2 was developed and validated by Roberts et al. (2008) as a means to further enhance the original VMIQ (Isaacs et al., 1986) and add a distinction in the visual modalities. The VMIQ-2 measures imagery ability from three aspects: internal visual imagery, external visual imagery and kinesthetic imagery, comprising 12 movements for each subscale, resulting in 36 items in total. Movements include whole body movements such as “running upstairs” and “jumping off a high wall”. Each is rated on a 5 point Likert scale ranging between 1 (*Perfectly clear and as vivid as normal vision or movement*) to 5 (*No image at all, you only “know” you are thinking of the skill*).

Focus group schedule. A series of questions were created, centred on two key themes. The first theme asked participants to consider the original VMIQ-2 items and comment specifically on the phrasing and suitability of these items for use with wheelchair sports athletes. The second theme of questions centred on discussing alternative, new items that could be considered in the creation of the WIAQ. Participants were reminded that the items needed to be suitable for use in wheelchair sports. Supplementary questions were used to follow up or add clarity to the participants’ responses whilst also ensuring that participants had the opportunity to add any further thoughts or ideas at the end of the focus group.

Procedure

Wheelchair athletes from a national wheelchair basketball team were invited to participate in a focus group by way of a participant information sheet. Those who volunteered were invited to attend a focus group held in a meeting room adjacent to their training venue. Due to the availability of the athletes two focus groups were conducted. Both focus groups were led by the first author who has training and experience of conducting qualitative research including focus groups and working within disability sport. On arrival, the participants were briefed on the purpose of the focus groups and asked to provide informed consent. The focus groups were recorded using a Dictaphone set up in the middle of the room and each focus group lasted approximately 50 minutes.

At the beginning of the focus group, participants were informed on the purpose of the research and its multistage nature, with the focus groups being stage 1 and the subsequent administration of the new set of items which the participants will have created in stage 1 to a large sample of wheelchair athletes being stage 2. Participants were provided with a copy of the original VMIQ-2 (Roberts et al., 2008) and asked to discuss the suitability of the measure when considering it for use in their sport (wheelchair basketball). Following this, participants were asked to highlight and discuss any unsuitable items and to suggest some alternative items that they would consider to be more suitable for use to measure imagery ability in wheelchair athletes (not just in wheelchair basketball). The researcher explained that the new measure that was being created out of their suggested items, would be similar to the VMIQ-2, in that it would assess imagery ability in the three different forms and that participants would be asked to rate how vivid each image was on the Likert scale. On completion of this process, the athletes were de-briefed and thanked for their time.

Data analysis

In line with the process followed by Williams and Cumming (2011), a Content Validity Index (CVI; Lynn, 1986) was used to establish which items should be retained for the next stage in the creation of the WIAQ. The lead researcher addressed each of the newly suggested items in turn with every participant and asked the participants to rate each item in terms of its quality on a scale of 1 – 6 (*1 being a very poor match and 6 being an excellent match*). Items that were rated as a good match (4), a very good match (5) or an excellent match (6) were included in the process (no items were rated less than a good match). The next step in the process was to calculate an overall CVI value for each item. This was done by dividing the number of participants (6) who rated the item as a good match, a very good match, or an excellent match to a subscale by the total number of athletes involved in the rating exercise process. The process was then repeated with three accredited (British Psychological Society and British Association of Sport and Exercise Science) Sport Psychology experts; one an applied sport psychologist specialising in disability sport, another an expert in research analysis and measurement and the third an expert in the area of imagery. In total 9 individuals were used in the process (6 participants and 3 experts). The focus groups were transcribed verbatim and subsequently reviewed and analysed for themes and ideas. In order to ensure trustworthiness of the data, peer debriefing was conducted at each stage of the analysis and an independent analysis of the transcripts was carried out by the first and second author (Lincoln & Guba, 1985).

Results and Discussion

The participants identified a number of pertinent factors for consideration during the focus groups and the process of identifying suitable items for inclusion in the newly created measure, the Wheelchair Imagery Ability Questionnaire (WIAQ). This included ensuring the items (movements) being created were physically possible for the population for which they are intended and non-inclusion of items which could evoke negative images for the user (and so would be counterproductive to the aims of imagery use). There was a large amount of discussion and frustration at unsuitability of the original VMIQ-2 for wheelchair sport athletes but it is important to bear in mind that the VMIQ-2 was never intended to be used with AWD, making the creation of the WIAQ even more pertinent. It was important to ensure that the newly created items were specific, yet generic enough, to appeal to a wide range of wheelchair sport participants so as not to limit its usage. All of these considerations had to be made whilst ensuring that the items being created made use of disability appropriate language. On commencing the focus groups, it became apparent that the group felt the need to discuss and define the parameters around what constitutes a wheelchair sport, so as to ensure the item creation was suitable for the audience for which it was intended. One participant commented,

> *…what are you including as a wheelchair sport? Some of the guys that throw the club (in athletics) and things like that are really severe CP (cerebral palsy), so pushing their chair isn't even possible for them but they are wheelchair users.*

This point made for an interesting discussion about which group of wheelchair users we wanted to focus on and further highlights the complex nature of different disabilities and conditions. Discussions extended to include whether or not to differentiate the items between those who are physically able to walk (but who still qualify as a wheelchair sport user as determined by their classification in that sport) versus those who make use of a manual wheelchair (as opposed to electric wheelchair) for daily mobility use. It was agreed that it needed to be made explicit that the items were being created for an active wheelchair user making use of a manual chair which has an active and dynamic part in their sport (e.g., wheelchair basketball, rugby, tennis and racing). However, this level of specificity would exclude certain sports where athletes transfer out of their chair and to a fixed point in order to perform such as javelin and discus for some classifications or to sports that do not make use of a chair but are a recognised para sport e.g., swimming. All participants indicated their support for wheelchair specific movements given that the WIAQ was being created purposefully to target individuals who would make use of a chair for the *purpose of their sport* and therefore agreed that the athletes completing the measures should be encouraged to imagine the items from the *perspective of their sports chair* rather than switching between sports chair, day chair, being stood up (if able to either aided or unaided) as this would make the items difficult to standardize across so many sports and considering so many physical conditions.

> *I think that keeps the focus (in wheelchair) because, if you ask, "if you can walk then…", well already that could create negativity for people, if they can't walk, especially if it is someone that's newly injured, or something like that. You know that could be quite a barrier to their engagement. Or then if you are saying if you can imagine yourself doing this, it could have negative connotations for people looking at it. So if you are going down it's a wheelchair sport specific questionnaire then why wouldn't it be based on a wheelchair?*

These important subtleties further highlight the complex nature of disability sport, where often there can be assumptions made about how different conditions affect functional ability (see Martin, 2015 for a review).

In terms of suitability of the original VMIQ-2 items, all six participants commented on the overwhelming unsuitability of the items with another acknowledging that there are condition specific factors that need to be considered when designing the items to help prevent any negative connotations or images or offense that may be caused indirectly,

> *I looked at this and there were two things (movements) I could do – "bending to pick up a coin" and "throwing a stone into water"…again something as fine and detailed as that could cause an issue. Some athletes might not be able to do that either…in fact they might have looked at this (original VMIQ-2) and not been able to do any of that.*

So there's a danger of being too vague in what you put here for fear of offending people versus it being specific enough that someone can see it and then the imagery has a very specific guide to it.

One participant specifically indicated frustration at the general automatic reaction to changing any lower limb movement specific items to be an upper body movement item. The participant acknowledged that this was a "*natural thing for people to do*" but ultimately felt that the movement should still purposefully involve the lower part of the wheelchair users body,

I think it should be something that we would associate with us using our chair…so it could be pushing something with your chair… like your chair hitting the front of something cos that's more like your legs…it should be like your chair is making contact with something.

On completion of the focus groups, the participants were asked to rank each of the newly created items for use in the WIAQ as a process of content validity. Of the 24 items, seven were below the 0.8 criteria which is considered necessary to be a valid item for inclusion (Lynn, 1986), but despite this the items were retained for the purpose of initial analysis in Study 2 before final conclusions could be made about the suitability of the items. Thus, Study 1 resulted in 24 items (see supplementary material) being generated by the elite athletes and experts as items for use in the newly formed WIAQ for further examination.

Study 2: Measurement validation

The aim of the second study was to determine the psychometric properties of the new 24 Wheelchair Imagery Ability Questionnaire (WIAQ) developed in Study 1. To do so, Bayesian Structural Equation Modelling (BSEM; Muthèn & Asparouhov, 2012) was used.

Participants

The WIAQ was administered online to participants recruited from a range of countries and clubs using the Bristol Online Survey Tool. In total, 117 participants completed the questionnaire from 11 different countries. Two participants were excluded from the sample based on their level of English language as both reported only understanding basic English. They were excluded to ensure accuracy of the data set and full understanding of the questions being asked resulting in 115 participants being included in the analysis. Participants were aged between 16 – 69 years old (*M* = 31.46, *SD* = 12.40*)*, 62 were male (53.9%) and 53 were female (46.1%) and they were from 13 different adapted sports including: wheelchair basketball (70), wheelchair rugby (8), wheelchair curling (6), wheelchair tennis (5), athletics (4), badminton (2), archery (2), swimming (1), shooting (2), sailing (1), water-skiing (1), alpine skiing (1) and then 11 athletes who competed in multiple sports including those mentioned as well as powerlifting (1). Participants had been playing their sports for between 0 and 40 years (*M* = 9.62; *SD* = 8.01).

Measures

Wheelchair Imagery Ability Questionnaire (WIAQ). The 24 item measure developed in Study 1 was utilized, assessing the three types of imagery; Internal visual Imagery (IV), External visual imagery (EVI) and Kinaesthetic Imagery (KVI). Each subscale comprised 24 items therefore totalling 72 items. Movements assessed in each of the items were created with a wheelchair user in mind and include movements such as “pushing up a ramp”, “pushing at speed” and “transferring into the car”. As in the VMIQ-2, each item on the WIAQ is rated on a 5 point Likert scale ranging from 1 (*Perfectly clear and as vivid as normal vision or movement*) to 5 (*No image at all, you only “know” you are thinking of the skill*).

Procedure

Given the WIAQ was drawn up for online administration, the layout of the questionnaire was modified from that of the original VMIQ-2 (Roberts et al., 2008) for ease of completion.

Participants were first asked for basic demographic information, level of English understanding (written and spoken) before being asked to consider the 24 adapted items from an external perspective, rating the vividness of each image as per the original ranking of the VMIQ-2 (Roberts et al., 2008). Participants were then presented with the same adapted 24 items and asked to consider these from an internal visual perspective and finally using kinesthetic imagery. At selected intervals in the questionnaire, the participant's level of attention was checked to ensure they were concentrating on the questions being asked. Concentration check questions included "Friday comes before Saturday" and "The American flag is red, white and blue". If an athlete answered either of these questions incorrectly, they were excluded from the sample. No athlete answered the concentration check questions inaccurately. The online link was distributed via a number of methods, including social media platforms, via wheelchair sports clubs and organisations in the U.K. and abroad. Once participants had completed all items, they were thanked, debriefed on the purpose of the study and were provided details of the first author if they wished to discuss the research further.

Data analysis

The factor structure of the questionnaire was examined using Bayesian Structural Equation Modelling (BSEM; Muthèn & Asparouhov, 2012), using Mplus version 7.3 (Muthèn & Muthèn, 1998-2012). This novel method of analysis has increasingly been utilised in sport and exercise psychology research (e.g., Stenling, Ivarsson, Johnson, & Lindwell, 2015; Niven & Markland, 2016). This method provides an alternative approach to the traditional confirmatory factor analysis (CFA) using maximum-likelihood (ML), as it acknowledges that models are likely to have small cross-loadings and co-variations across indicators. Traditionally, ML approaches fix cross loadings and residual correlations to zero, leading to an overly strict model and to rejection of the model by the likelihood ratio χ^2 test (Marsh et al., 2009). In contrast, the BSEM method allows small variances, cross-loadings and correlated residuals within identified models by specifying model priors, meaning that model misspecification is less likely (see Asparouhuv & Muthèn, 2009; Niven & Markland, 2016 for a detailed overview). This method is particularly suited to the current context as the same items are used in each of the subscales of the questionnaire, meaning that cross-loadings and correlated residuals are likely to be evident simply as a matter of item content. Thus taking cross-loadings and correlated residuals into account results in a more appropriate assessment of model fit.

Following the recommendations of Muthèn and Asparhouv (2012) a series of BSEM models were estimated. Firstly, the model was estimated with non-informative priors for major loadings, exact zero cross-loadings and exact zero residual correlations. The second model included informative approximate zero cross loadings and the final model the informative approximate zero cross loadings and residual correlations. The prior variances for cross-loadings and residual correlations were specified at ±.01. This size of prior corresponds to factor loadings and residual correlations with a 95% limit of ± .20, which represents relatively small cross loadings and residual correlations (Muthèn & Asparhouv, 2012; Niven & Markland, 2016). Although the BSEM approach usually advocates that all factors are tested simultaneously, the researchers in the current study tested the factor structure of the WIAQ at a single factor level first. This approach was taken to increase the chance of convergence because of the small sample size in this study and therefore the cross loadings at the single factor level are not reported. In addition, sensitivity analysis is advocated when estimating BSEM models to assess the stability of the estimates (Gucciardi & Zyphur, 2016; Muthèn & Asparhouv, 2012). Therefore, once the series of BSEM models had been run and a final factor structure established, the analyses was run smaller (.005) and larger (.015) prior variances for the cross loadings and parameter estimates.

All BSEM model analysis was conducted using the Markov Chain Monte Carlo (MCMC) simulation with the Gibbs sampler. Estimation was conducted using 100,000 iterations to check for convergence and stability of the estimates. In addition, convergence was assessed by the potential scale reduction (PSR) test, with PSR values between 1.0 and 1.1 indicating convergence (Gelman, Carlin, Stern, & Rubin, 2004). Trace plots were also inspected to visually inspect the stability of means and variances across chains. In line with Muthèn and Asparhouv (2012) all analysis on standardized data and model fit was examined by inspection of the posterior predictive *p* value (PPP value) and examination of the symmetric 95% confidence interval for the difference of the observed and replicated. A PPP value around .50 is an indicator of good model fit with values below .50 an indicator of unacceptable model fit (Muthèn & Asparhouv, 2012). When inspecting the symmetric 95% confidence interval values centred around zero are indications of a good fitting model.

The analysis for this study was conducted in two stages. Firstly, a sequential model testing strategy was adopted, in which each factor (EVI, IVI and KIN) was examined separately. This separate analysis allows any potential problematic items to be identified and removed and only those that were good indictors of the underlying factor to be retained. In this analysis, model fit was examined as well as the factor loadings. Items were considered for removal based on their theoretical relevance, if they have had significant correlated residuals with another item, and if the CVI reported in Study 1 was below 0.8. Items that were a problem in one factor, were subsequently removed from the other two factors so to develop a set of items that could be used consistently across the three perspectives. Following this single factor and item removal stage, the full model was specified using the three BSEM models outlined above.

Results

Single factor analysis

The single factor analysis for the 24 item model achieved adequate convergence and all factor loadings were significant. However, a number of items appeared problematic in the analysis process and were considered for removal. A staged process of item deletion was completed, whereby items were deleted and the model was re-specified. Items were considered for removal based on theoretical relevance and if there was significant correlated residuals with another item greater than .20 in one or more of the single factor analysis. Once this process was complete a 15 item model was examined. Adequate convergence was achieved for all of the 15 item BSEM models for EVI, IVI and KIN. The PPP's for each factor with zero cross-loadings and zero residual correlations indicated a poor fit to the data. The PPP's for the model with informative priors on residual correlations indicated a good fit to the data and the symmetric 95% posterior predictive confidence intervals encompassed zero. The PPP of .525, .570, .572 for EVI, IVI and KIN respectively indicate an excellent fit for the final 15 item model (see Table 1). All factor loadings in the 15 item EVI, IVI and KIN were significant (see Table 2). In addition, the PSR values for each of these models reached convergence at 8300, 5500, 8400 iterations respectively and inspection of the trace plots provided further support for adequate convergence.

Three factor model

The three factor 15 item model was tested using the three BSEM models (Table 1). Adequate convergence was achieved for the three factor 15 item in all BSEM models. The PSR values for the models reached the 1.1 criterion after 700, 900, and 44700 iterations respectively, and inspection of the trace plots further supported adequate convergence of the model. The PPP for zero cross-loadings and zero residual correlations indicated a poor fit to the data. The PPP for the model with informative priors on the cross loadings also indicated a poor fit to the model. The PPP for the model with informative priors on the cross loadings and residual correlations indicated a good fit to the data and the symmetric 95% posterior predictive confidence intervals encompassed zero. The PPP of .662 indicated a reasonable fit to the data and all factor loadings were significant. The interfactor correlations between the three imagery factors were as follows; EVI with IVI = .71 [.59, .80], EVI with KIN = .48 [.30, .63], and IVI with KIN = .63 [.49, .74].

In addition to this, sensitivity analysis was completed with specification of both larger (.015) and smaller (.005) variance priors. For the WIAQ, 100% of discrepancies fell between ± .05 and the maximum discrepancy was .02 with prior variances set at .015. With prior variances set at .005; 100% of the discrepancies fell between ± .05 and the maximum discrepancy was .03. This indicates that the factor loadings and cross-loadings were stable when using larger and smaller variances.

Discussion

This study demonstrates the value of adopting a BSEM approach for the assessment of the factorial validity of measurement instruments and provide initial support for a 15 item WIAQ. However, the process of instrument development is ongoing and therefore further validation of the measurement model is required.

Study 3: Further validation

The aim of Study 3 was to assess concurrent validity of the WIAQ by examining correlations between WIAQ scales and other validated imagery questionnaires. Two questionnaires were used to assess the validity of the WIAQ; the Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011) and the practice and competition imagery subscales of the Test of Performance Strategies-2 (TOPS-2; Hardy, Roberts, Thomas, & Murphy, 2010). Although there is no gold standard measure for imagery ability and these questionnaires are not designed specifically for athletes using a wheelchair, both measures were considered appropriate because they have both established internal consistency and have reliable factorial validity. In addition, both measures do not refer to physical movements, as such, wheelchair athletes are capable of completing both of these measures without any movement related issues as is the case when using the VMIQ-2. Therefore, it is expected that the concurrent validity of the

WIAQ would be established by significant correlations between the WIAQ and the SIAQ and TOPS-2 imagery sub-scales.

Method

The same participants from Study 2 completed Study 3, therefore all participants and procedures are the same.

Measures

Wheelchair Imagery Ability Questionnaire (WIAQ). The 15 item WIAQ from Study 2 was used as a predictor.

Sport Imagery Ability Questionnaire (SIAQ; Williams & Cumming, 2011). The SIAQ is a 15 item questionnaire designed to measure athlete's ability to image different content that they frequently use in their sport. The measure can provide an overall global score for imagery ability, in addition to a score for five discrete factors. These include imaging skills, strategies, goals, feeling and emotions and mastering difficult situations. Items are rated on a 7 point Likert scale ranging from 1 (*very hard to image*) to 7 (*very easy to image*). The structural validity of this measure has been reported in a series of studies (Williams & Cumming, 2011; Cumming & Williams, 2012) as well as adequate internal reliability and composite reliability.

Test of Performance Strategies-2 (TOPS-2; Hardy et al., 2010). The imagery sub-scales from the TOPS-2 measure were used. This scale contains four items that assessed the use of imagery in practice situations, and four items that assessed imagery use in competition situations. Items are rated on a 5 point Likert scale ranging from 1 (*never*) to 5 (*always*). Both subscales have good factorial validity and have acceptable Cronbach alpha values (practice = .72, competition = .86).

Data Analysis

To assess the strength of the relationship between the scores on the WIAQ and the scores on the SIAQ and TOPS-2 Pearson's product-moment correlations were calculated. Analysis was completed on the three factors from the WIAQ, the global SIAQ score as well as the five lower order factors and the practice and competition subscale from TOPS-2.

Results

All data was analysed for normality, however the normality tests revealed that all variables were significantly (p > .05) non normal. Data was thus checked for outliers and 12 were identified, these were removed and further normality tests were conducted. The data remained non-normal, therefore, subsequent analysis using the non-parametric equivalent Spearman's correlation coefficient (Spearman, 1910) was conducted to complete the analysis.

The results (Table 3) revealed the three WIAQ factors of EVI, IVI, and KIN were significantly correlated with the SIAQ global score; EVI and SIAQ, $r = .39$, $p < .001$; IVI and SIAQ, $r = .26$, $p = .004$; KIN and SIAQ, $r = .20$, $p = .028$. In addition, EVI and IVI were significantly correlated with all five of the lower order factors in the SIAQ measure (i.e., imaging skills, strategies, goals, feeling and emotions and mastering difficult situations). For KIN, only the strategies ($r = .23$, $p =.010$) and affect ($r = .19$, $p = .034$) factors of the SIAQ were significantly correlated.

The results also revealed that the EVI and KIN perspectives of the WIAQ were significantly correlated to the TOPS-2 practice and competition sub-scale; EVI and TOPS-2 practice ($r = .23$, $p = .010$), competition ($r = .27$, $p = .003$); KIN and TOPS-2 practice ($r = .21$, $p = .024$), competition ($r = .27$, $p = .003$). Interestingly, no significant correlations were revealed between the IVI perspective and the practice and competition subscales of the TOPS-2 measure.

Discussion

The aim of Study 3 was to examine the concurrent validity of the newly developed WIAQ. Analyses supported the concurrent validity of the 15 item three factor measure. Caution must be applied when interpreting the lack of significance relationships between IVI and the TOPS-

2 subscales as the TOPS has been referred to as a fairly “blunt” instrument (Hardy et al, 2010), as its intended purpose was to be used in conjunction with other psychometric tests in order to give an overall picture of psychological skills use in athletes. Furthermore, the imagery items in TOPS-2 do not fully distinguish between different types of imagery. Some may argue that the TOPS-2 items contain an EVI and KIN focus, potentially offering a reason why it might be expected that no relationship was evident with the IVI factor in the WIAQ. However, as the IVI is positively related with the SIAQ factors, these results provide further validation for the WIAQ and provide support for a measure that is suitable for wheelchair athletes. The results of Study 2 and Study 3 should be viewed as especially noteworthy due to the nature of the athletes utilized in the sample and it should be recognised and acknowledged that it can be a challenge to recruit from such a narrow population of athletes. Thus, the results are particularly pertinent as support for the new measure has been provided despite a relatively small sample size.

General Discussion

The current research addresses the call for more research in the area of applied sport psychology specifically focusing on the needs and practices within disability sport, including making available more appropriate modified measures for AWD (e.g. Arnold et al., 2017). To the best of our knowledge, this is the first study that outlines the development and validation as well as the application of a measure solely for the use with a wheelchair population making use of BSEM analysis. The use of BSEM analysis is becoming accepted as an innovative method to test measurement models (Niven & Markland, 2016), thus this paper provides a good example how this approach can be applied in the sport psychology field. This initial model development and analysis provides a first step into development of specific measures for AWD. However, further testing is still required as measurement development is an ongoing process. It should be recognized however, that future researchers may also face a challenge when invariance testing given the small number of athletes being drawn from in a population of athletes with a disability.

Although the WIAQ still requires further use in an applied context to help assess its reliability and validity across a wide range of wheelchair athletes, the results of the current research have highlighted that the measure could be utilized in other contexts, namely a rehabilitation setting to help offer alternatives or support for other measures such as the KVIQ-20 and its shorter counterpart, the KVIQ-10 (Malouin et al., 2007). Although the sample of athletes used for creation of the WIAQ was limited to wheelchair sports athletes (purely for the basis of item creation and to set some parameters for initial use of the measure), with the requirement that they utilized imagery of each item from their sports chair, the WIAQ could be used by a broader range of wheelchair user to increase its usability. When creating the WIAQ, the primary focus was on wheelchair sport athletes however care was taken to ensure that the items were all non-sporting physical movements (similar to that of the VMIQ-2; Roberts et al., 2008). As a result of the careful measure design, the WIAQ comprises movements that could be considered physically possible for a wheelchair user, be that of a sporting or non-sporting nature making the WIAQ suitable for a range of contexts including in a rehabilitation setting, for those who utilize a wheelchair for daily mobility use and in wheelchair sports. Schuster et al. (2011) indicated that imagery has been shown to be beneficial in the recovery of motor function in individuals post lesion of the Central Nervous System (e.g., stroke), indicating that if mental practice in the form of imagery is included in the rehabilitation programme, this positively aids recovery. Without suitable measures to assess the use of imagery in such diverse populations, this makes it challenging to assess any of the changes in imagery, with Schuster et al. (2011) indicating that the research that does exist primarily uses custom made questionnaires.

The WIAQ is one of the only wheelchair measures that has undergone rigorous development and validation, adding to the limited resources available to assess imagery use in this specific population. Although initially designed with the wheelchair athlete in mind, the WIAQ is multifaceted in its use, given its suitability in sporting and non-sporting contexts. The various contexts require testing and the authors make a call for this in future research. Additionally, more research needs to focus specifically on the performance related issues of AWD, whilst remaining sensitive to the subtle needs of the athletes. Such research needs to move beyond the simple notion that AWD can utilize and benefit from sport psychology support and should focus on interventions, measurement development and case studies of practitioners who are actively working with AWD and outlining the strategies and interventions that appear to work across a range of disabilities and disability sports. Young applied sport psychologists need to be exposed to the concept of working with AWD and view this as a challenge, in the sense that every athlete is a challenge, every athlete requires an individual approach given that every athlete has their own needs that require consideration – this should not be pre-determined, prejudged or prefixed by disability.

Conclusion

The findings of this research provide initial support for the newly developed WIAQ. The results demonstrate the acceptable psychometric properties of the measure whilst using BSEM as a novel method of analysis. Thus, the study contributes to the literature by providing a measure that can be used with AWD and by utilizing a theoretically grounded approach to measurement validation. Most importantly, the development of this measure clearly addresses the need to develop measures that are useable and designed with AWD in consideration.

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Table 1

BSEM fit and convergence

Model	Difference between observed and replicated χ^2 95% CI				
	No. free parameters	PPP	Lower 2.5%	Upper 2.5%	PSR
EVI					
Non-informative	44	0	314.55	392.73	1
Informative with residuals	149	0.525	-49.49	45.03	1
IVI					
Non-informative	44	0	252.46	330.9	1
Informative with residuals	149	0.57	-51.5	41.78	1
KIN					
Non-informative	44	0	258.81	337.33	1
Informative with residuals	149	0.572	-51.49	41.85	1
Full model					
Non-informative	135	0	1951.94	2177.76	1.001
Informative priors (cross loadings)	228	0	1902.34	2131.75	1
Informative priors (cross loadings + residual correlations)	1218	0.662	-176.29	116.94	1.04

Note: PPP = posterior predictive p value; PSR = potential scale reduction

Table 2

Single factor WIAQ standardized factor loadings with 95% credibility intervals in bracket

Item	**External**	**Internal**	**Kinaesthetic**
Pushing in your chair	0.95[.83, 1.01]	0.93[.81, 1.0]	0.8[.60, 1.01]
Sprinting in your chair	0.96[.84, 1.10]	0.96[.85, 1.08]	0.98[.91, 1.17]
Changing direction in your chair	0.97[.85, 1.09]	0.97[.84, 1.11]	0.98[.89, 1.14]
Throwing a stone	0.8[.58, 1.02]	0.87[.69, 1.05]	0.81[.62, 1.02]
Bending to pick up a bag	0.83[.61, 1.05]	0.92[.75, 1.09]	0.99[.85, 1.14]
Sprinting up a ramp	0.81[.60, 1.03]	0.96[.82, 1.10]	0.99[85, 1.16]
Getting into your sports chair	0.97[.82, 1.14]	0.85[.67, 1.03]	0.98[.88, 1.16]
Using your chair to ram another chair out of the way	0.86[.67, 1.05]	0.86[.68, 1.05]	0.94[.78, 1.11]
Moving backwards	0.95[.79, 1.12]	0.89[.72, 1.07]	0.99[.84, 1.15]
Throwing a stone into water	0.82[.60, 1.03]	0.86[.67, 1.06]	0.9[.72, 1.10]
Pushing down a ramp	0.87[.67, 1.08]	0.87[.70, 1.05]	0.88[.72, 1.06]
Throwing a ball in the air	0.96[.80, 1.12]	0.98[.84, 1.13]	0.99[.84, 1.15]
Pulling on a rope	0.88[.67, 1.08]	0.94[.77, 1.10]	0.9[.73, 1.09]
Getting out of the car	0.84[.63, 1.05]	0.88[.73, 1.05]	0.94[.78, 1.11]
Pull up (assisted or not assisted)	0.81[.60, 1.02]	0.84[.67, 1.02]	0.9[.73, 1.08]

Table 3

Bivariate correlations between WIAQ, SIAQ and TOPS-2 imagery sub-scales

	EVI	IVI	KIN	SIAQ Global	SIAQ Skill	SIAQ Strategy	SIAQ Goal	SIAQ affect	SIAQ Mastery	TOPS practice	TOPS competition
EVI	-										
IVI	.71**	-									
KIN	.48**	.63**	-								
SIAQ Global	.42**	.28**	.18*	-							
SIAQ Skill	.39**	.26**	.15	.92**	-						
SIAQ Strategy	.34**	.24**	.20*	.83**	.75**	-					
SIAQ Goal	.34**	.19*	.09	.81**	.70**	.47**	-				
SIAQ Affect	.35**	.27**	.18*	.81**	.70**	.60**	.53**	-			
SIAQ Mastery	.33**	.20*	.10	.89**	.80**	.73**	.69**	.65**	-		
TOPS Practice	.23**	.15	.22*	.43**	.35**	.42**	.37**	.33**	.32**	-	
TOPS comp	.27**	.17	.26**	.48**	.40**	.48**	.38**	.33**	.44**	.71**	-

Note: * $p < .05$; ** $p < .01$