

1 Running head: Development and validation of the WIAQ

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

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

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

1 (2017) recently offered a refreshing investigation into the organisational stressors encountered
2 by AWD revealing, somewhat unsurprisingly, that AWD encountered similar stressors to those
3 of able-bodied athletes. However, of more interest was that the AWD disclosed a range of
4 distinct, disability specific stressors that were reported to impact on their sporting performance.
5 These included, but were not limited to, issues with inaccessible venues, lack of disability
6 specific coaching and training opportunities, lack of crowds at disability events and the
7 disability classification system. Additionally, Arnold et al. (2017) supported the claims of
8 others (e.g., Dieffenbach & Statler, 2012) indicating that despite an interest in sport psychology
9 support, lack of access to a psychologist is a further stressor for AWD. Arnold et al. (2017)
10 made a call for service providers and psychologists to consider creative ways to support AWD
11 and develop and implement “appropriate and impactful, evidence based stress management
12 interventions” (p.1195).

13 In an attempt to answer Arnold et al.’s (2017) call, the current paper shares a series of
14 studies focusing on the use of imagery in AWD. Within able-bodied sport and applied sport
15 psychology, the use of imagery as a vehicle for improving performance is a well-established
16 and researched topic (for reviews, see Cumming & Williams, 2012; Malouin, Richards,
17 Jackson, Lafleur & Doyon, 2007). For example, it is well established that individuals who have
18 the ability to imagine their movements accurately, vividly and with ease demonstrate greater
19 improvements in their performance compared to those who struggle to use imagery (e.g., Robin
20 et al., 2007). Furthermore, imagery is a popular mental technique used by coaches and athletes
21 with the intention of enhancing self-regulation of thoughts, feelings and behaviors in successful
22 elite athletes (Cumming & Williams, 2013). Within disability sport research, there is some
23 useful but limited evidence specifically focusing on the benefits of imagery use in adapted
24 water-skiing (De Bressy et al., 2013) and wheelchair rugby (Martin & Malone, 2013). Martin
25 and Malone (2013) investigated the use of imagery (and self-talk) and indicated that wheelchair

1 rugby players make use of both cognitive (e.g., skill learning) and motivational (e.g., increase
2 effort) forms of imagery. Despite these studies recognising that AWD are able to make use of
3 basic psychological skills including imagery, little is known about AWD use of imagery and
4 ability to image given a lack of relevant psychometric measures available. The omission of
5 suitable imagery ability tools is an important factor for consideration for researchers and
6 practitioners interested in imagery use in AWD. If practitioners are to support AWD effective
7 use of imagery, then there is a requirement to understand how well these athletes can image.

8 If AWD are to be included in sport psychology support and interventions, then
9 practitioners and researchers need to consider the appropriateness of the measures available to
10 assess mental skills. This is important if appropriate interventions are to be designed and
11 implemented for this population of athlete. De Bressy de Guast et al. (2013) focused on imagery
12 use in wheelchair water-skiing and stated that if the aim is to improve the performance of a
13 particular movement then athletes with disabilities need to imagine themselves in a real
14 competitive situation and this includes visualising the chair that they perform in. This point is
15 further supported by Hanrahan (1995) and later by Szameitat, Shen and Sterr (2007) who stated
16 that for wheelchair athletes, the chair needs to be a part of the image being created as it is a
17 necessary piece of equipment just as any other piece of equipment needs to be part of the
18 visualization process for athletes without disabilities (such as a tennis racket or a golf club) and
19 must be both familiar and physically possible to execute by the wheelchair athlete. Previous
20 research has attempted to make some basic, initial adaptations to existing but predominately
21 “able bodied centric” psychometrics. Shearer, Mellalieu, Shearer & Roderique-Davies (2009)
22 identified that the original Vividness of Movement Imagery Questionnaire (VMIQ; Isaac,
23 Marks & Russell, 1986) was designed for able-bodied athletes, in other words those who have
24 functional capacity in all limbs. As such, some of the items would not be relevant to those who
25 do not have lower limb function (e.g., Spina Bifida, Spinal Cord Injury, Polio). Through the

1 use of focus groups, Shearer et al. (2009) adapted the VMIQ items for use in their study of
2 wheelchair basketball players by simply replacing items that requested participants to imagine
3 lower body movements with upper body ones – a simple and effective adaptation but the
4 adapted items had not been subjected to any measurement validation analysis and therefore
5 may not be reliable or valid for use beyond the scope of the context they were used in. Shearer
6 et al. (2009) indicated that few modified assessment tools are available and that there is a need
7 for the development of these for future practice as well as more guidelines for working with
8 athletes with disabilities.

9 As not to dismiss the existing measures that could be used with AWD, there are a number
10 that *could* be deemed suitable to measure the broad construct of imagery ability but each have
11 their own limitations and issues for consideration. These include the Sport Imagery Ability
12 Questionnaire (SIAQ; Williams & Cumming, 2011), which focuses on athletes use of strategy
13 and planning for their performance so is useful however no physical movements are alluded to
14 in the measure. Another measure is the Kinaesthetic and Visual Imagery Questionnaire-20
15 (KVIQ-20; Malouin et al., 2007) which has been used more widely in the rehabilitation setting.
16 The KVIQ-20, and a shortened 10 item version, was developed to be used in participants with
17 sensorimotor impairments and in particular has been evaluated in patients after stroke, those
18 with a lower limb amputation, those with acquired blindness and Parkinson’s disease (Page,
19 Levine & Leonard, 2005; Malouin et al., 2007; Shuster, Lussi, Writh & Ettlin, 2012). Most of
20 the movements required of the participants in the KVIQ-20 are static movements so do not
21 require the individuals to imagine themselves travelling / moving which would be common
22 place in athletes. Within a sporting context, the most popular measures available are the
23 Movement Imagery Questionnaire-3 (Williams et al., 2012) and Vividness of Movement
24 Imagery Questionnaire-2 (Roberts et al., 2008) both of which are drawn from the able-bodied
25 literature and are focused on functional everyday dynamic movements. However, many of the

1 items make reference to movements that a wheelchair user could struggle to physically execute
2 (e.g., “stand with both feet shoulder width apart” and “imagine yourself running upstairs”) and
3 these are therefore limited in their current unmodified versions.

4 Imagery ability is often assessed via vividness of an image, the ease of image creation or
5 a combination of the two. Ease and vividness are highly correlated (Williams & Cumming,
6 2011) and in an attempt to create a new measure that focuses specifically on measuring imagery
7 ability in wheelchair sport users we needed a conceptual framework to guide the creation and
8 development of the new measure. Given its credibility and popularity, and its use in a wide
9 range of disciplines such as sport psychology, cognitive psychology and neuroscience (e.g.,
10 Callow & Roberts, 2010; Jiang, Edwards, Mullins, & Callow, 2015) this framework was based
11 on the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts et al., 2008). The
12 VMIQ-2 is a development of the original VMIQ (Isaacs et al., 1986) and is a well-established
13 and utilized measure of imagery ability that measures three aspects of imagery: imaging
14 movements looking out through one’s own eyes (Internal visual imagery, IVI), imaging
15 watching oneself perform a movement (External visual imagery, EVI) and imaging the feel of
16 a movement (Kinesthetic imagery, KI), comprising 12 movements for each subscale, resulting
17 in 36 items in total. Movements include whole body movements such as “running upstairs”
18 and “jumping off a high wall”. Each is rated on a 5 point Likert scale ranging between 1
19 (*Perfectly clear and as vivid as normal vision or movement*) to 5 (*No image at all, you only*
20 *“know” you are thinking of the skill*). While the VMIQ-2 demonstrates appropriate
21 psychometric properties, and has also received support of its validity from a neural perspective
22 (see Jiang et al., 2015) on close inspection, it is evident that the VMIQ-2 is wholly unsuitable
23 for use with a wheelchair population (sporting or otherwise). For example, 10 out of the 12
24 movements are highly difficult or physically impossible for a wheelchair user to execute. These
25 items include walking, running, kicking a stone, running upstairs, jumping sideways, kicking

1 a ball in the air, running downhill, riding a bike, swinging on a rope and jumping off a high
2 wall. Due to the unsuitability of the measure it is evident that new items needed to be created
3 and a measure specifically designed for wheelchair sports athletes.

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

13 **Study 1 – Development of the WIAQ**

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

19 **Method**

20 **Participants**

21 A purposefully selected sample of six elite female wheelchair athletes (*Mean age* = 25.17,
22 *SD* = 2.83) were invited to take part in two focus groups, consisting of three athletes in each
23 focus group. All participants were national level wheelchair basketball players with a range of
24 years' experience in the sport (*M* = 8.83, *SD* = 2.66), and international experience (*M* = 6.33,
25 *SD* = 2.5), with all representing their country in at least one Paralympic Games. All participants

1 provided consent to take part in the focus group. The participants had a variety of different
2 physical impairments including spinal cord injuries, motor neuropathy, proximal focal femoral
3 deficiency and Cerebral Palsy. There was a combination of both congenital (4) and acquired
4 conditions (2).

5 **Measures**

6 **Vividness of Movement Imagery Questionnaire–2 (VMIQ-2; Roberts et al. 2008).**

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

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

1 **Procedure**

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

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

24 **Data analysis**

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

20 **Results and Discussion**

21 The participants identified a number of pertinent factors for consideration during the focus
22 groups and the process of identifying suitable items for inclusion in the newly created measure,
23 the Wheelchair Imagery Ability Questionnaire (WIAQ). This included ensuring the items
24 (movements) being created were physically possible for the population for which they are
25 intended and non-inclusion of items which could evoke negative images for the user (and so

1 would be counterproductive to the aims of imagery use). There was a large amount of
2 discussion and frustration at unsuitability of the original VMIQ-2 for wheelchair sport athletes
3 but it is important to bear in mind that the VMIQ-2 was never intended to be used with AWD,
4 making the creation of the WIAQ even more pertinent. It was important to ensure that the
5 newly created items were specific, yet generic enough, to appeal to a wide range of wheelchair
6 sport participants so as not to limit its usage. All of these considerations had to be made whilst
7 ensuring that the items being created made use of disability appropriate language. On
8 commencing the focus groups, it became apparent that the group felt the need to discuss and
9 define the parameters around what constitutes a wheelchair sport, so as to ensure the item
10 creation was suitable for the audience for which it was intended. One participant commented,
11 *...what are you including as a wheelchair sport? Some of the guys that throw the club*
12 *(in athletics) and things like that are really severe CP (cerebral palsy), so pushing their*
13 *chair isn't even possible for them but they are wheelchair users.*
14 This point made for an interesting discussion about which group of wheelchair users we wanted
15 to focus on and further highlights the complex nature of different disabilities and conditions.
16 Discussions extended to include whether or not to differentiate the items between those who
17 are physically able to walk (but who still qualify as a wheelchair sport user as determined by
18 their classification in that sport) versus those who make use of a manual wheelchair (as opposed
19 to electric wheelchair) for daily mobility use. It was agreed that it needed to be made explicit
20 that the items were being created for an active wheelchair user making use of a manual chair
21 which has an active and dynamic part in their sport (e.g., wheelchair basketball, rugby, tennis
22 and racing). However, this level of specificity would exclude certain sports where athletes
23 transfer out of their chair and to a fixed point in order to perform such as javelin and discus for
24 some classifications or to sports that do not make use of a chair but are a recognised para sport
25 e.g., swimming. All participants indicated their support for wheelchair specific movements

1 given that the WIAQ was being created purposefully to target individuals who would make use
2 of a chair for the *purpose of their sport* and therefore agreed that the athletes completing the
3 measures should be encouraged to imagine the items from the *perspective of their sports chair*
4 rather than switching between sports chair, day chair, being stood up (if able to either aided or
5 unaided) as this would make the items difficult to standardize across so many sports and
6 considering so many physical conditions.

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

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

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

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

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

14 **Measures**

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

23 **Procedure**

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

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

15 **Data analysis**

16 The factor structure of the questionnaire was examined using Bayesian Structural Equation
17 Modelling (BSEM; Muthèn & Asparouhov, 2012), using Mplus version 7.3 (Muthèn &
18 Muthèn, 1998-2012). This novel method of analysis has increasingly been utilised in sport and
19 exercise psychology research (e.g., Stenling, Ivarsson, Johnson, & Lindwell, 2015; Niven &
20 Markland, 2016). This method provides an alternative approach to the traditional confirmatory
21 factor analysis (CFA) using maximum-likelihood (ML), as it acknowledges that models are
22 likely to have small cross-loadings and co-variations across indicators. Traditionally, ML
23 approaches fix cross loadings and residual correlations to zero, leading to an overly strict model
24 and to rejection of the model by the likelihood ratio χ^2 test (Marsh et al., 2009). In contrast, the
25 BSEM method allows small variances, cross-loadings and correlated residuals within identified

1 models by specifying model priors, meaning that model misspecification is less likely (see
2 Asparouhuv & Muthèn, 2009; Niven & Markland, 2016 for a detailed overview). This method
3 is particularly suited to the current context as the same items are used in each of the subscales
4 of the questionnaire, meaning that cross-loadings and correlated residuals are likely to be
5 evident simply as a matter of item content. Thus taking cross-loadings and correlated residuals
6 into account results in a more appropriate assessment of model fit.

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

24 All BSEM model analysis was conducted using the Markov Chain Monte Carlo (MCMC)
25 simulation with the Gibbs sampler. Estimation was conducted using 100,000 iterations to check

1 for convergence and stability of the estimates. In addition, convergence was assessed by the
2 potential scale reduction (PSR) test, with PSR values between 1.0 and 1.1 indicating
3 convergence (Gelman, Carlin, Stern, & Rubin, 2004). Trace plots were also inspected to
4 visually inspect the stability of means and variances across chains. In line with Muthèn and
5 Asparhouv (2012) all analysis on standardized data and model fit was examined by inspection
6 of the posterior predictive p value (PPP value) and examination of the symmetric 95%
7 confidence interval for the difference of the observed and replicated. A PPP value around .50
8 is an indicator of good model fit with values below .50 an indicator of unacceptable model fit
9 (Muthèn & Asparhouv, 2012). When inspecting the symmetric 95% confidence interval values
10 centred around zero are indications of a good fitting model.

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

21 **Results**

22 **Single factor analysis**

23 The single factor analysis for the 24 item model achieved adequate convergence and all
24 factor loadings were significant. However, a number of items appeared problematic in the
25 analysis process and were considered for removal. A staged process of item deletion was

1 completed, whereby items were deleted and the model was re-specified. Items were considered
2 for removal based on theoretical relevance and if there was significant correlated residuals with
3 another item greater than .20 in one or more of the single factor analysis. Once this process
4 was complete a 15 item model was examined. Adequate convergence was achieved for all of
5 the 15 item BSEM models for EVI, IVI and KIN. The PPP's for each factor with zero cross-
6 loadings and zero residual correlations indicated a poor fit to the data. The PPP's for the model
7 with informative priors on residual correlations indicated a good fit to the data and the
8 symmetric 95% posterior predictive confidence intervals encompassed zero. The PPP of .525,
9 .570, .572 for EVI, IVI and KIN respectively indicate an excellent fit for the final 15 item
10 model (see Table 1). All factor loadings in the 15 item EVI, IVI and KIN were significant (see
11 Table 2). In addition, the PSR values for each of these models reached convergence at 8300,
12 5500, 8400 iterations respectively and inspection of the trace plots provided further support for
13 adequate convergence.

14 **Three factor model**

15 The three factor 15 item model was tested using the three BSEM models (Table 1).
16 Adequate convergence was achieved for the three factor 15 item in all BSEM models. The PSR
17 values for the models reached the 1.1 criterion after 700, 900, and 44700 iterations respectively,
18 and inspection of the trace plots further supported adequate convergence of the model. The
19 PPP for zero cross-loadings and zero residual correlations indicated a poor fit to the data. The
20 PPP for the model with informative priors on the cross loadings also indicated a poor fit to the
21 model. The PPP for the model with informative priors on the cross loadings and residual
22 correlations indicated a good fit to the data and the symmetric 95% posterior predictive
23 confidence intervals encompassed zero. The PPP of .662 indicated a reasonable fit to the data
24 and all factor loadings were significant. The interfactor correlations between the three imagery

1 factors were as follows; EVI with IVI = .71 [.59, .80], EVI with KIN = .48 [.30, .63], and IVI
2 with KIN = .63 [.49, .74].

3 In addition to this, sensitivity analysis was completed with specification of both larger
4 (.015) and smaller (.005) variance priors. For the WIAQ, 100% of discrepancies fell between
5 $\pm .05$ and the maximum discrepancy was .02 with prior variances set at .015. With prior
6 variances set at .005; 100% of the discrepancies fell between $\pm .05$ and the maximum
7 discrepancy was .03. This indicates that the factor loadings and cross-loadings were stable
8 when using larger and smaller variances.

9 **Discussion**

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

14 **Study 3: Further validation**

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

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

3 **Method**

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

6 **Measures**

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

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

17 **Test of Performance Strategies-2 (TOPS-2; Hardy et al., 2010).** The imagery sub-scales
18 from the TOPS-2 measure were used. This scale contains four items that assessed the use of
19 imagery in practice situations, and four items that assessed imagery use in competition
20 situations. Items are rated on a 5 point Likert scale ranging from 1 (*never*) to 5 (*always*). Both
21 subscales have good factorial validity and have acceptable Cronbach alpha values (practice =
22 .72, competition = .86).

23 **Data Analysis**

24 To assess the strength of the relationship between the scores on the WIAQ and the scores
25 on the SIAQ and TOPS-2 Pearson's product-moment correlations were calculated. Analysis

1 was completed on the three factors from the WIAQ, the global SIAQ score as well as the five
2 lower order factors and the practice and competition subscale from TOPS-2.

3 **Results**

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

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

16 The results also revealed that the EVI and KIN perspectives of the WIAQ were
17 significantly correlated to the TOPS-2 practice and competition sub-scale; EVI and TOPS-2
18 practice ($r = .23, p = .010$), competition ($r = .27, p = .003$); KIN and TOPS-2 practice ($r = .21,$
19 $p = .024$), competition ($r = .27, p = .003$). Interestingly, no significant correlations were
20 revealed between the IVI perspective and the practice and competition subscales of the TOPS-
21 2 measure.

22 **Discussion**

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

1 2 subscales as the TOPS has been referred to as a fairly “blunt” instrument (Hardy et al, 2010),
2 as its intended purpose was to be used in conjunction with other psychometric tests in order to
3 give an overall picture of psychological skills use in athletes. Furthermore, the imagery items
4 in TOPS-2 do not fully distinguish between different types of imagery. Some may argue that
5 the TOPS-2 items contain an EVI and KIN focus, potentially offering a reason why it might be
6 expected that no relationship was evident with the IVI factor in the WIAQ. However, as the
7 IVI is positively related with the SIAQ factors, these results provide further validation for the
8 WIAQ and provide support for a measure that is suitable for wheelchair athletes. The results
9 of Study 2 and Study 3 should be viewed as especially noteworthy due to the nature of the
10 athletes utilized in the sample and it should be recognised and acknowledged that it can be a
11 challenge to recruit from such a narrow population of athletes. Thus, the results are particularly
12 pertinent as support for the new measure has been provided despite a relatively small sample
13 size.

14 **General Discussion**

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

1 when invariance testing given the small number of athletes being drawn from in a population
2 of athletes with a disability.

3 Although the WIAQ still requires further use in an applied context to help assess its
4 reliability and validity across a wide range of wheelchair athletes, the results of the current
5 research have highlighted that the measure could be utilized in other contexts, namely a
6 rehabilitation setting to help offer alternatives or support for other measures such as the KVIQ-
7 20 and its shorter counterpart, the KVIQ-10 (Malouin et al., 2007). Although the sample of
8 athletes used for creation of the WIAQ was limited to wheelchair sports athletes (purely for the
9 basis of item creation and to set some parameters for initial use of the measure), with the
10 requirement that they utilized imagery of each item from their sports chair, the WIAQ could
11 be used by a broader range of wheelchair user to increase its usability. When creating the
12 WIAQ, the primary focus was on wheelchair sport athletes however care was taken to ensure
13 that the items were all non-sporting physical movements (similar to that of the VMIQ-2;
14 Roberts et al., 2008). As a result of the careful measure design, the WIAQ comprises
15 movements that could be considered physically possible for a wheelchair user, be that of a
16 sporting or non-sporting nature making the WIAQ suitable for a range of contexts including in
17 a rehabilitation setting, for those who utilize a wheelchair for daily mobility use and in
18 wheelchair sports. Schuster et al. (2011) indicated that imagery has been shown to be beneficial
19 in the recovery of motor function in individuals post lesion of the Central Nervous System
20 (e.g., stroke), indicating that if mental practice in the form of imagery is included in the
21 rehabilitation programme, this positively aids recovery. Without suitable measures to assess
22 the use of imagery in such diverse populations, this makes it challenging to assess any of the
23 changes in imagery, with Schuster et al. (2011) indicating that the research that does exist
24 primarily uses custom made questionnaires.

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

16 **Conclusion**

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

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- 1 Table 1
- 2 *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

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

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- 9

1 Table 2

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]

3

1 Table 3

2 *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**	-

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

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