1   **Abstract**

2   This study explored the relation between athletes' sleep quality and imagery ability. A total

3   of 201 athletes (39.3% female, 60.7% male; $M_{age} = 23.28$ years, $SD = 6.00$) completed the

4   Sport Imagery Ability Questionnaire (SIAQ) and the Pittsburgh Sleep Quality Index (PSQI).

5   Simple regression analyses revealed that global sleep quality predicted affect imagery ability.

6   Multiple regression analyses revealed that daytime dysfunction predicted global imagery

7   ability as well as skill, strategy, affect, and mastery imagery ability dimensions. In addition,

8   use of sleeping medication predicted global imagery ability, as well as goal and affect

9   imagery ability dimensions. Results provide some support for Cumming and Williams'

10   (2012) revised applied model of deliberate imagery use, suggesting that individual factors

11   influence the effectiveness of imagery use. Specifically, athletes who have no disruption to

12   daily functioning due to sleep find it easier to image sport-related content.

13   *Key words:* athletes, sleep quality, imagery ability, revised applied model of

14   deliberate imagery use

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1   **The Effects of Sleep Quality on Imagery Ability in Athletic Populations**

2   Imagery is possibly the most cited intervention method in sport psychology literature, with a

3   total of 245 academic papers in the last 5 years alone addressing this topic (search completed

4   on SportDiscus using search terms "imagery" AND "sport", and limited to academic journals).

5   White and Hardy (1998) describe11 imagery as "an experience that mimics real experience.

6   We can be aware of "seeing" an image, feeling movements as an image, or experiencing the

7   real thing… It differs from dreams in that we are awake and conscious when we form an image"

8   (p. 389). In sport, imagery refers to the mental representation of sport relevant actions, and has

9   been associated with changes in cognitions, behaviors and thoughts in athletic populations

10   (Martin, Moritz, & Hall, 1999).

11   Over the past two decades, sport-based imagery research has focused on the five types

12   of imagery outlined in Paivio's (1985) conceptual framework and the Sport Imagery

13   Questionnaire (Hall, Mack, Paivio & Hausenblas, 1998): (1) cognitive-specific (imagery of

14   specific sport skills), (2) cognitive general (imagery of strategies/tactical plays), (3)

15   motivational specific (imagery of specific goal orientated behaviors), (4) motivational general-

16   mastery (imagery of effective coping and mastery of challenging situations), and (5)

17   motivational general-arousal (imagery that represents feelings of relaxation, stress, arousal and

18   anxiety). Investigations into imagery practice and effectiveness have explored a plethora of

19   factors including the impact of sporting ability and experience (e.g., Gregg & Hall, 2006),

20   different theoretical approaches or modus operandi (e.g., Wright & Smith, 2009), and different

21   imagery types and their relationship to other psychological constructs (e.g., Cumming, Olphin,

22   & Law, 2007; Shearer, Thomson, Mellalieu, & Shearer, 2007). One of the most explored

23   factors in sport imagery literature is that of imagery ability (e.g., Gregg, Hall, McGowan, &

24   Hall, 2011; Wilson, Smith, Burden, & Holmes, 2010, Williams & Cumming, 2012), which can

1   be defined as "an individual's capability to form vivid, controllable images and retain them for

2   sufficient time to effect the desired imagery rehearsal" (Morris, Spittle, & Watt, 2005, p. 37).

3   In 2012, Cumming and Williams introduced the revised applied model of deliberate

4   imagery use, which extended from Martin, Moritz and Hall's (1999) widely adopted original

5   model in four ways. First, the revised applied model acknowledges the importance of the

6   individual performing the imagery (who), placing particular emphasis on individual

7   characteristics that may influence imagery function and effectiveness. Second, the revised

8   applied model distinguishes between the type of imagery (what) and the function that it is used

9   for (why), suggesting that a specific imagery type can serve different functions depending on

10 the meaning associated with the imagery content. Third, the revised applied model clarifies

11 the role of imagery ability, outlining its impact on what and how an individual images, as well

12 as the outcomes associated with imagery use. Finally, the revised applied model accounts for

13 the diverse application of imagery, outlining how imagery interventions can be used across

14 domains such as dance, exercise, and rehabilitation in addition to sport.

15   Paivio (1986) outlined that all athletes have the capacity to image to some extent, but

16 that imagery ability will vary across individuals (i.e., a person may be more/less able to

17 generate imagery) and within individuals subject to the imagery content (i.e., a person may be

18 more able to generate cognitive versus motivational images). This is in keeping with the "who"

19 aspects outlined in Cumming and Williams' (2012) model, which suggest that individual

20 factors such as age, gender, competitive level, and psychological traits and states will impact

21 upon imagery effectiveness (Cumming & Williams, 2013). Indeed, several factors are thought

22 to relate to imagery ability, including athletic experience (Abma, Fry, Li, & Relyea, 2002),

23 emotion regulation (Anuar, Cumming, & Williams, 2016), observation and movement priming

24 (Williams, Cumming, & Edwards, 2011), and corticospinal activation (Williams, Pearce,

25 Loporto, Morris, & Holmes, 2012). However, no consensus exists concerning the factors that

1   might affect athletes' ability to generate effective images and to the best of our knowledge no

2   research has explored the impact of physiological factors associated with recovery status (e.g.,

3   sleep quality) upon imagery ability.

4   Sleep is an essential requirement for all basic human functions (Dattilo et al., 2011;

5   Meerlo, Sgoifo, & Suchecki, 2008) and is known to affect the autonomic nervous system,

6   endocrine system, and biochemical function when disrupted (e.g., Spiegel, Leproult, & Van

7   Cauter, 1999). From a psychological perspective, poor sleep also effects cognitive factors (e.g.,

8   Belenky et al., 2003) and mood states (e.g., Sinnerton & Reilly, 1992) and is therefore likely

9   to contribute to poor decision making and motivation to train (either physically or mentally).

10   Restricted sleep is a known problem in modern society (Meerlo et al., 2008), and also within

11   elite athlete populations (e.g., Leeder, Glaister, Pizzoferro, Dawson, & Pedlar, 2012). This

12   restriction is down to a combination of lifestyle (e.g., unsocial working hours), behavioral (e.g.,

13   poor sleep hygiene), and psychological factors (e.g., perceived stress level). In addition,

14   athletes specifically suffer disruptions as a direct function of their sporting activity. Research

15   demonstrates that training volume (Jürimäe, Mäestu, Purge, & Jürimäe, 2004), training times

16   (Sargent, Halson, & Roach, 2014), and competition all impact on athletes sleep quality

17   (Shearer, Jones, Kilduff, & Cook, 2015).

18   Sleep is reported to impact attention, working memory, long-term memory, motivation,

19   and visuo-motor performance, outlining its importance towards cognitive functioning (see

20   Alhola & Polo-Kantola, 2007 for a review). There is also consistent support, spanning

21   behavioral and neurophysiological studies, for the role of sleep in memory consolidation (see

22   Stickgold, 2005 for a review). The role of memory in the generation of mental imagery is well

23   explained from both a theoretical and empirical standpoint (Paivio 1985; Tong, 2013).

24   Therefore, the relationship that both sleep and imagery hold with memory indicates that sleep

25   will impact an individual's ability to generate imagery.

1   In general terms, the topics of imagery and sleep have often been considered together

2   in the literature. For instance, there is some evidence that sleep plays an important role in the

3   consolidation of learning following a motor imagery intervention (Debarnot, Creveaux, Collet,

4   Doyon, & Guillot, 2009; Debarnot et al., 2009). In addition, imagery has been used as an

5   intervention to treat sleep nightmares in patients with Post Traumatic Stress Disorder (e.g.,

6   Berlin, Means, & Edinger, 2010; Harb, Thompson, Ross, & Cook, 2012). However, to our

7   knowledge in athletic populations or otherwise, no research has considered how sleep quality

8   effects imagery ability. Imagery ability is likely impacted by the quality of sleep due to the

9   effect poor sleep has on cognitive factors such as attention (e.g., Belenky et al., 2003), and

10   motivational factors such as mood states (e.g., Sinnerton & Reilly, 1992). The aim of this study

11   was to explore the relationship between the imagery ability of specific imagery types (cf.

12   Williams & Cumming, 2011) and sleep quality in an athletic population ranging in ability from

13   amateur to elite/international and professional. Based on a number of individual characteristics

14   influencing imagery effectiveness for athletes (e.g., emotional regulation; Anuar et al., 2016)

15   and the apparent influence of sleep on outcomes associated with imagery (e.g., learning

16   consolidation; Debarnot et al., 2009), it was hypothesized that global sleep quality and the

17   seven components of sleep quality will predict imagery ability in athletic populations.

18   **Method**

19   *Participants*

20   Participants ($N = 201$, females $= 79$, males $= 122$; $M_{age} = 23.28$ years, $SD = 6.00$) were

21   sampled from a number of universities in the UK and internationally via social media posts

22   circulated at regular intervals during the data collection period. Participants competed in a

23   wide range of sports ($N = 27$), with the most common team-based sports being soccer ($n = 57$),

24   rugby ($n = 16$), volleyball ($n = 12$), and basketball ($n = 8$), and the most common individually-

25   based sports being swimming ($n = 13$), martial arts ($n = 12$), tennis ($n = 10$), and boxing ($n =$

1   9). The current competitive level of the participants ranged from amateur ($n = 183$) to

2   professional/international level athletes ($n = 18$). The study participants had been competing

3   in their respective sports for an average of 8.97 ± 6.29 years.

4   ***Measures***

5   ***Individual characteristics.*** The study participants provided the research team with

6   information regarding their age, gender, primary sport, current competitive level, and years of

7   playing experience.

8   ***Pittsburgh Sleep Quality Index.*** The Pittsburgh Sleep Quality Index (PSQI; Buysse,

9   Reynolds, Monk, Berman, & Kupfer, 1989) was used to assess the perceived sleep quality of

10   the athlete participants. The PSQI comprises 19 items with 7 components related to sleep

11   habits over a one-month period prior to completion: subjective sleep quality (1 item), sleep

12   latency (2 items), sleep duration (1 item), habitual sleep efficiency (3 items), sleep disturbances

13   (9 items), use of sleeping medication (1 item), and daytime dysfunction (2 items). All

14   component scores are calculated using specific scoring instructions (see Buysse et al.), with

15   scores ranging from 0 (no difficulty) to 3 (severe difficulty) for each component. A global

16   score can also be calculated for the PSQI by combining the seven component scores, with a

17   range of 0 (no difficulty) to 21 (severe difficulty) for this global index. The PSQI has

18   demonstrated good internal reliability and test-retest reliability in clinical and non-clinical

19   settings (see Mollayeva et al., 2015 for a meta-analysis).

20   ***Sport Imagery Ability Questionnaire.*** The Sport Imagery Ability Questionnaire

21   (SIAQ; Williams & Cumming, 2011) was used to assess the ability of respondents to image

22   different types of imagery content. The questionnaire comprises 15 items with 5 subscales

23   related to different types of imagery ability: skill (3 items), strategy (3 items), goal (3 items),

24   affect (3 items), and mastery (3 items). Participants rated their ease of imaging for each item

25   using 7-point likert scale anchored by 1 (very hard to image) and 7 (very easy to image). The

1   scale underwent extensive validation during initial design comprising of 1 exploratory factor

2   analysis, 2 progressive confirmatory factor analysis, and a final study examining the scales

3   construct validity alongside the Movement Imagery Questionnaire-3 (MIQ-3; Williams,

4   Cumming, Ntoumanis, Nordin-Bates, Ramsey, & Hall, 2012). In the final study, the scale

5   showed robust goodness of fit indices ($\chi 2$ (80) = 108.59, $p < .05$, CFI = .98, TLI = .97, SRMR

6   = .04, RMSEA = .04) and satisfactory levels of composite reliability for all 5 subscales (.78-

7   .86). In this study, satisfactory Cronbach alpha scores were reported for the SIAQ (global =

8   .88), with questionable to good scores reported for the subscales of this measure (skill = .73,

9   strategy = .60, goal = .82, affect = .80, mastery = .68).

10   ***Procedure***

11   Ethical approval was granted by the lead authors university ethics committee and all

12   participants provided informed consent prior to taking part in the study. An online survey pack

13   was developed using an online-survey provider (www.surveymonkey.com). The survey pack

14   contained a participant consent form, demographic questionnaire, PSQI, SIAQ, and participant

15   debrief form (presented in that order). Prior to involvement in the study, all participants were

16   notified that engagement with this study was voluntary, they had the right to withdraw at any

17   time during/after the study, and that the information provided would be treated confidentially

18   and stored securely on password-protected computers for all research team members. The

19   online questionnaire took approximately ten minutes to complete in full.

20   ***Data Analyses***

21   All statistical procedures were conducted using a minimum significance level of $p = .05$. First,

22   data were screened for univariate normality, multivariate normality, and multicollinearity.

23   Second, regression analyses were run to explore the direction and relative contribution of sleep

24   quality towards variance in imagery ability. Specifically, simple regression analyses were used

25   to examine whether the global PSQI score predicted SIAQ scores (global, five subscales), and

1   forced entry multiple regression analyses were used to examine whether the seven PSQI

2   component scores predicted SIAQ scores (global, five subscales).

3   **Results**

4   *Data Screening*

5   For the final study sample, there were no missing values. Cook's distances were used to

6   examine the assumptions of multivariate normality, with a value greater than 1 indicative of

7   multivariate outliers (cf. Cook & Weisberg, 1982). For all regression analyses, Cook's

8   distance values were below 1 with a maximum value of 0.16 ($M = 0.01$, $SD = 0.01$),

9   indicating that no single case greatly influenced the respective models, leaving 201 cases for

10   each analysis. The variance inflation factor values were all below 10 with a maximum value

11   of 1.76 ($M = 1.31$, $SD = 0.23$) and the tolerance statistic scores were all above 0.20 with a

12   minimum value of 0.68 ($M = 0.78$, $SD = 0.12$), indicating no collinearity within the data.

13   Pearson's correlations were used to account for potential variance in sleep quality as a

14   function of 'years played' ($r = .08$) and 'highest level played' ($r = .03$) and indicated no

15   significant relationship between any of these variables ($p > .05$).

16   [INSERT TABLE 1 HERE]

17   *Global Sleep Quality: Imagery Ability*

18   The relationship between global sleep quality and imagery ability was assessed using six

19   regression analyses. The first simple regression analysis identified that the global sleep

20   quality score accounted for 1.10% of variability in the global imagery ability score ($\beta = -.11$,

21   R^2 change $= .01$, $F_{1-199} = 2.29$, $p > .05$). Further simple regression analyses identified that the

22   global sleep quality score predicted affect imagery ability score, but not scores for the four

23   other imagery ability subscales. Specifically, global sleep quality score accounted for 0.30%

24   of variability in skill imagery ability ($\beta = -.05$, R^2 change $= .01$, $F_{1-199} = 0.59$, $p > .05$), 0.00%

25   of variability in strategy imagery ability ($\beta = -.00$, R^2 change $= .00$, $F_{1-199} = 0.00$, $p > .05$),

1   0.80% of variability in goal imagery ability (β = -.09, R^2 change = .01, $F_{1\text{-}199}$ = 1.64, p > .05),

2   2.70% of variability in affect imagery ability (β = -.16, R^2 change = .03, $F_{1\text{-}199}$ = 5.47, p <

3   .05), and 0.60% of variability in mastery imagery ability (β = -.08, R^2 change = .01, $F_{1\text{-}199}$ =

4   1.17, p > .05).

5   ***Components of Sleep Quality: Imagery Ability***

6   The relationship between the components of sleep quality and imagery ability was assessed

7   using six multiple regression analyses. The first multiple regression analysis reported that the

8   sleep quality components accounted for 14.00% of variability in global imagery ability.

9   Daytime dysfunction (β = -.28, R^2 change = .14, $F_{7\text{-}193}$ = 4.47, p < .001) and use of sleeping

10   medication (β = -.15, R^2 change = .14, $F_{7\text{-}193}$ = 4.47, p < .05) were identified as significant

11   predictors towards the global imagery ability score. All other sleep quality components were

12   not significant predictors of global imagery ability (p > .05).

13   [INSERT TABLE 2 HERE]

14   The second multiple regression analysis reported that the sleep quality components accounted

15   for 9.90% of variability in skill imagery ability. Daytime dysfunction (β = -.23, R^2 change =

16   .10, $F_{7\text{-}193}$ = 3.03, p < .01) was identified as the only significant predictor towards the skill

17   imagery ability score. All other sleep quality components were not significant predictors of

18   skill imagery ability (p > .05).

19   [INSERT TABLE 3 HERE]

20   The third multiple regression analysis reported that the sleep quality components accounted

21   for 9.00% of variability in strategy imagery ability. Daytime dysfunction (β = -.24, R^2

22   change = .09, $F_{7\text{-}193}$ = 2.72, p < .01) was identified as the only significant predictor towards

23   the strategy imagery ability score. All other sleep quality components were not significant

24   predictors of strategy imagery ability (p > .05).

25   [INSERT TABLE 4 HERE]

1 The fourth multiple regression analysis reported that the sleep quality components accounted

2 for 8.30% of variability in goal imagery ability. Use of sleeping medication (β = -.16, R^2

3 change = .08, $F_{7\text{-}193}$ = 2.51, $p < .05$) was identified as the only significant predictor towards

4 the goal imagery ability score. All other sleep quality components were not significant

5 predictors of goal imagery ability ($p > .05$).

6 [INSERT TABLE 5 HERE]

7 The fifth multiple regression analysis reported that the sleep quality components accounted

8 for 13.00% of variability in affect imagery ability. Daytime dysfunction (β = -.21, R^2 change

9 = .13, $F_{7\text{-}193}$ = 4.12, $p < .01$) and use of sleeping medication (β = -.26, R^2 change = .13, $F_{7\text{-}193}$

10 = 4.12, $p < .001$) were identified as significant predictors towards the global imagery ability

11 score. All other sleep quality components were not significant predictors of goal imagery

12 ability ($p > .05$).

13 [INSERT TABLE 6 HERE]

14 The sixth multiple regression analysis reported that the sleep quality components accounted

15 for 10.80% of variability in mastery imagery ability. Daytime dysfunction (β = -.33, R^2

16 change = .11, $F_{7\text{-}193}$ = 3.32, $p < .001$) was identified as the only significant predictor towards

17 the mastery imagery ability score. All other sleep quality components were not significant

18 predictors of mastery imagery ability ($p > .05$).

19 [INSERT TABLE 7 HERE]

20 **Discussion**

21 The aim of the current study was to examine the predictive capabilities of sleep quality

22 towards imagery ability in an athletic population. Specifically, we examined whether athlete

23 sleep quality predicted imagery ability in athletes. It was hypothesized that sleep quality

24 (global & seven components) would positively predict imagery ability (global & five types).

25 The study findings provide partial support of this hypothesis. Somewhat surprisingly, global

1   sleep quality did not predict global imagery ability, and only held a predictive relationship

2   with affect imagery ability. This suggests that athletes who have higher overall quality of

3   sleep tend to be more able to generate imagery with content directed towards the positive

4   emotions associated with participation in sport (e.g., excitement, happiness). It is

5   consistently reported that sleep, and more specifically sleep deprivation, impacts negatively

6   upon a person's emotional states (e.g., Paterson et al., 2011), emotional regulation (e.g.,

7   Baum et al., 2014), perception of emotions (e.g., Daniela, Alessandro, Giuseppe, Fabio, &

8   Cristina, 2010), and ability to express emotions (Minkel, Htaik, Banks, & Dinges, 2011). In

9   combination, these findings suggest that if an athlete has a high quality of sleep they are

10 likely to be able to understand and express emotions more accurately. Given that affect

11 imagery involves the generation of images of positive emotions related to sport, it is

12 conceivable that sleep will impact upon an athlete's ability to generate this imagery type

13 through its relationship with emotion.

14   When exploring the predictive relationship between the seven components of sleep

15 quality and imagery ability, it was found that daytime dysfunction and use of sleeping

16 medication are the only two predictors of imagery ability types. Specifically, daytime

17 dysfunction predicted global, skill, strategy, affect, and mastery imagery ability, and use of

18 sleeping medication predicted global, goal, and affect imagery ability. It is surprising that

19 just two of seven sleep quality components predict imagery ability due to the apparent

20 relationship between sleep, mental imagery and memory. However, these findings may be

21 partially explained by the general sleep characteristics of the sample used in this study.

22 Leeder et al. (2012) report that sleep quality and quantity are worse for elite athletic

23 compared to non-athletic populations, whereas a study by Selby, Weinstein and Bird (1990)

24 found that 68% of student athletes reported that they got sufficient sleep for a maximum of

25 two nights per week. Based on these studies, it is understandable that on average our athlete

1 cohort are diagnosed to have sleep disorder ($M = 6.05$) based on general population

2 guidelines (Buysse et al., 1989). This disordered sleeping is likely to be a long-term issue

3 which may be seen as 'the norm' for this population type. It is possible that the athletes in

4 this study do not believe their sleep duration or sleep quality to be 'non-normal' unless they

5 perceive it to impact upon their actual behavior (i.e., daytime functioning or use of

6 medication). Everyday functioning in sport incorporates both cognitive and physical tasks,

7 with athletes using all types of imagery fairly frequently within their sporting involvement

8 (e.g., Gregg, Hall, & Nederhof, 2005). The use of sleeping medication is said to impact

9 daytime functioning through cognitive and/or physical impairment (e.g., Verster,

10 Veldhuijzen, & Volkerts, 2004), outlining the impact that this can have upon subsequent

11 behavior, including the effective application of imagery.

12   The study findings lend partial support to Cumming and Williams' (2012) adaptation

13 of the "who" component in the revised applied model of deliberate imagery use, whereby

14 greater importance is placed on the individual performing the imagery. A multitude of

15 individual characteristics are reported to influence imagery function, effectiveness, and the

16 outcomes associated with its use (Cumming & Williams, 2013). Our results show that global

17 sleep quality and specific components of sleep quality (daytime dysfunction, use of sleep

18 medication) impact upon different types of imagery ability in sport. It is possible that poor

19 sleep quality will reduce an athlete's ability to recall memories, function cognitively, and

20 understand emotions, all important aspects of imagery development in sport. This finding

21 outlines the potential importance of physiological variables as a separate category of

22 individual differences for imagery use in sport, exercise, rehabilitation, and dance. All of

23 these domains require some form of physical and mental exertion, suggesting a need to better

24 understand the relationships between physiological states and imagery. Specifically, there is

25 a need to consider recovery-based indicators such as fatigue, hydration status, and

1 injury/illness when applying imagery interventions and monitoring the outcomes associated

2 with imagery use.

3   This study undoubtedly has its merits, including the recruitment of a split-gender

4 sample of athletes from a wide variety of sports, and the extensive psychometric assessment

5 of sleep quality and imagery ability in sport. However, a number of limitations exist

6 surrounding the cross-sectional design and assessment methods used in this study. First, we

7 did not account for the influence of experimental demands on the results, whereby

8 participants may have guessed the study aims and answered questions accordingly. Similarly,

9 as the PSQI was presented to participants before the SIAQ, an acknowledgement of sleep

10 dysfunction might have biased answers to the SIAQ. Correlation analysis to examine the

11 relationship between participants' expectation about the study and the actual results would

12 have been useful to check this (see Holmes, Mathews, Mackintosh, & Dagleish, 2008).

13   Second, although our design allowed the research team to examine the relationship

14 between sleep quality and imagery ability across a relatively large sample of athletes, it does

15 not permit understanding of causality. In this respect, there is a need to explore the

16 interrelations between sleep and imagery in greater depth. For instance, research is warranted

17 examining whether interventions targeting better quality sleep also improve an athlete's

18 ability to image and his/her subsequent effectiveness of imagery use. One such intervention

19 that has been used with athletes is sleep extension, which involves the employment of a strict

20 sleep regime with a minimum sleep duration over an extended period of time (see e.g., Mah,

21 Mah, Kezirian, & Dement, 2011). Additionally, there is a need to consider the recursive

22 relationship that may exist between sleep and imagery ability by exploring the use of

23 imagery-based training methods such as layered stimulus response training to improve sleep

24 quality in athletic populations (see Cumming et al., 2016). The recommended study foci

25 should incorporate multi-modal assessment of both sleep quality and imagery ability as

1   appropriate within the specific study designs. Alternative methods used to assess sleep

2   quality include sleep diaries and wrist activity monitors (e.g., Sargent, Lastella, Halson, &

3   Roach, 2014), whilst imagery ability has been measured objectively using physiological and

4   behavioral measures such as electroencephalography (Cremades & Pease, 2007), functional

5   magnetic resonance imaging (Cui, Jeter, Yang, Montague, & Eagleman, 2007), and

6   electromyography (Wilson et al., 2010).

7   In summary, this study extends the literature on the "who" component of Cumming

8   and Williams' (2012) revised applied model of deliberate imagery use by exploring the

9   relationship between sleep quality and imagery ability in athletes. Data analyses revealed

10   that global sleep quality predicted affect imagery ability, and that two components of sleep

11   quality (daytime dysfunction and use of sleep medication) predicted global imagery ability

12   and various imagery ability types. The findings of this study suggest that different

13   physiological factors are associated with differences in sport imagery ability in athletic

14   populations, thus providing support for Cumming and Williams' assertions that individual

15   characteristics warrant consideration when attempting to apply imagery affectively. Future

16   studies should explore the interrelations between sleep and imagery ability by attempting to

17   manipulate either variable and assessing the impacts upon both.

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1   Table 1

2   *Mean and standard deviation values for sleep quality and sport imagery ability scores*

	M	SD
Pittsburgh Sleep Quality Index		
Subjective Sleep Quality	1.13	0.75
Sleep Latency	1.44	0.90
Sleep Duration	0.40	0.72
Habitual Sleep Efficiency	0.45	0.82
Sleep Disturbances	1.35	0.52
Use of Sleeping Medication	0.15	0.57
Daytime Dysfunction	1.13	0.72
Global Sleep Quality	6.05	2.90
Sport Imagery Ability Questionnaire		
Skill Imagery Ability	4.42	0.90
Strategy Imagery Ability	4.23	0.87
Goal Imagery Ability	4.07	1.26
Affect Imagery Ability	4.84	1.02
Mastery Imagery Ability	4.15	0.97
Global Imagery Ability	4.34	0.76

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1 Table 2

2 *Summary of multiple regression analysis for sleep quality components predicting global*

3 *imagery ability score in athletes*

	B	B_{SE}	β
Constant	4.70	0.16	
Subjective Sleep Quality	0.06	0.09	.06
Sleep Latency	0.10	0.06	.11
Sleep Duration	-0.04	0.09	-.04
Habitual Sleep Efficiency	0.11	0.07	.12
Sleep Disturbances	-0.16	0.11	-.11
Use of Sleeping Medication	-0.20	0.09	-.15*
Daytime Dysfunction	-0.30	0.08	-.28***

4 *Note: B = Unstandardised Beta Coefficient, B_{SE} = Standard Error of B, β = Standardised*

5 *Beta Coefficient. N = 201, R^2=0.14, Adjusted R^2= 0.11, F_{7-193} =4.47, (* p < 0.05, *** p <*

6 *0.001).*

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1   Table 3

2   *Summary of multiple regression analysis for sleep quality components predicting skill*

3   *imagery ability score in athletes*

	B	B_{SE}	β
Constant	4.64	0.19	
Subjective Sleep Quality	0.04	0.11	.03
Sleep Latency	0.14	0.07	.14
Sleep Duration	-0.12	0.10	-.09
Habitual Sleep Efficiency	0.16	0.09	.15
Sleep Disturbances	-0.10	0.13	-.06
Use of Sleeping Medication	-0.13	0.11	-.09
Daytime Dysfunction	-0.29	0.10	-.23**

4   *Note: B = Unstandardised Beta Coefficient, B_{SE} = Standard Error of B, β = Standardised*

5   *Beta Coefficient. N = 201, R^2=0.10, Adjusted R^2= 0.07, F_{7-193} =3.03, (** p < 0.01).*

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1 Table 4

2 *Summary of multiple regression analysis for sleep quality components predicting strategy*

3 *imagery ability score in athletes*

	B	B_{SE}	β
Constant	4.50	0.19	
Subjective Sleep Quality	0.12	0.11	.11
Sleep Latency	0.10	0.07	.10
Sleep Duration	0.05	0.10	.04
Habitual Sleep Efficiency	0.08	0.08	.07
Sleep Disturbances	-0.19	0.13	-.11
Use of Sleeping Medication	-0.11	0.11	-.07
Daytime Dysfunction	-0.29	0.09	-.24**

4 *Note: B = Unstandardised Beta Coefficient, B_{SE} = Standard Error of B, β = Standardised*

5 *Beta Coefficient. N = 201, R^2=0.09, Adjusted R^2= 0.06, F_{7-193} =2.72, (** p < 0.01).*

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1   Table 5

2   *Summary of multiple regression analysis for sleep quality components predicting goal*

3   *imagery ability score in athletes*

	B	B_{SE}	β
Constant	4.60	0.27	
Subjective Sleep Quality	-0.07	0.15	-.04
Sleep Latency	0.12	0.10	.09
Sleep Duration	-0.03	0.15	-.01
Habitual Sleep Efficiency	0.19	0.12	.12
Sleep Disturbances	-0.33	0.18	-.14
Use of Sleeping Medication	-0.35	0.16	-.16*
Daytime Dysfunction	-0.18	0.14	-.10

4   *Note: B = Unstandardised Beta Coefficient, B_{SE} = Standard Error of B, β = Standardised*

5   *Beta Coefficient. N = 201, R^2=0.08, Adjusted R^2= 0.05, F_{7-193} =2.51, (** p < 0.01).*

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1   Table 6

2   *Summary of multiple regression analysis for sleep quality components predicting affect*

3   *imagery ability score in athletes*

	B	*B$_{SE}$*	*β*
Constant	5.21	0.21	
Subjective Sleep Quality	-0.00	0.12	-.00
Sleep Latency	0.09	0.08	.08
Sleep Duration	-0.06	0.12	-.04
Habitual Sleep Efficiency	0.08	0.09	.06
Sleep Disturbances	-0.08	0.14	-.04
Use of Sleeping Medication	-0.46	0.12	-.26***
Daytime Dysfunction	-0.30	0.11	-.21**

4   *Note: B = Unstandardised Beta Coefficient, B$_{SE}$ = Standard Error of B, β = Standardised*

5   *Beta Coefficient. N = 201, R^2=0.13, Adjusted R^2= 0.10, F_{7-193} =4.12, (** p < 0.01, *** p <*

6   *.001).*

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1   Table 7

2   *Summary of multiple regression analysis for sleep quality components predicting mastery*

3   *imagery ability score in athletes*

	B	B_{SE}	β
Constant	4.55	0.21	
Subjective Sleep Quality	0.19	0.12	.15
Sleep Latency	0.03	0.08	.03
Sleep Duration	-0.05	0.11	-.04
Habitual Sleep Efficiency	0.05	0.09	.04
Sleep Disturbances	-0.12	0.14	-.07
Use of Sleeping Medication	0.05	0.12	-.03
Daytime Dysfunction	-0.45	0.10	-.33***

4   *Note: B = Unstandardised Beta Coefficient, B_{SE} = Standard Error of B, β = Standardised*

5   *Beta Coefficient. N = 201, R^2=0.11, Adjusted R^2= 0.08, F_{7-193} =3.32, (*** p < .001).*

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