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Considering new moves in dance medicine and science: promoting a translational agenda for improved applied impact

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ABSTRACT

Over the past 35 years, the dance domain has adopted sports medicine as a key driver of professional practice. However, similar to limitations identified within sport, research is yet to achieve its full translational potential within applied settings. This *Viewpoints* paper begins to identify and unpick key philosophical and methodological aspects, with the view to stimulate discussion in this rapidly growing and developing domain. First, we outline a pragmatic philosophy that underpins expert professional practice as a basis to evaluate research. Second, we critically appraise study design characteristics to exemplify a gap between accepted scientific research protocols and professional needs within applied settings. Third, we comment on recommendations/insights made within the literature against the requirements and practices of professionals. Finally, based on this appraisal we suggest an exemplar new line of research that draws upon a pragmatic philosophy; namely, motor skill refinement. In enacting these 'new moves', we look forward to increased collaboration between practitioners and academics to fully realise a strong applied evidence-base. This task will not be easy, as with any interdisciplinary research, and should draw upon interdisciplinary expertise to do so. Hopefully our brief comments will provide a stimulus for further discussion, planning and future action.

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The development of sports medicine as a profession and research domain has become increasingly specialised over the past 35 years (Brennan 1986). With this, many other performance domains have recognised the potential benefits that can be achieved and have adopted a similar lens to professional support and knowledge generation. One domain that has seen growth in research and development is dance medicine and science (DMS; e.g., Amorim et al. 2015; Koutedakis and Jamurtas 2004). Indeed, it is only very recently that professional dance companies have employed clinicians and specialists to support the needs and performances of dancers; although this embedding of knowledge and understanding remains inconsistent across countries (Australia and Canada being early to include with others following), companies and choreographers. Moreover, an evidence-based approach is

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also being adopted within training academies, charged with the development of young talent into the professional ranks. In this regard, studies have provided data on biomechanics (Wilson and Kwon 2008), physiology (Ruscello et al. 2018), psychology (Zaletel and Kajtna 2020) and health (Fong Yan et al. 2018) topics, as notable examples. Unsurprisingly, the transfer of practices, methods and personnel from sport, has characterised this development; similarly between mainstream and Paralympic sports, for example (Collins, Simon, and Carson 2019). Whilst the majority of this research *is* original and contributing within the academic domain of DMS, we argue in this *Viewpoints* paper that it is yet to reach its full potential within applied practice. In this paper we begin to identify and unpick key philosophical and methodological aspects with the view to stimulate discussion in this rapidly growing and developing domain. First, we outline a philosophy that underpins expert professional practice as a basis from which evaluations of research can be made. Second, we critically appraise several study design characteristics to exemplify a gap between accepted scientific research protocols and the needs of professionals within DMS settings. Considering our backgrounds in dance pedagogy, coaching, biomechanics and motor control, these topics are where we focus our appraisals, but readers may wish to consider topics such as physiology or health. Third, we comment on recommendations/insights made within the academic DMS literature against the requirements and practices of the profession. Finally, based on this appraisal we suggest an exemplar, and much needed, new line of research for DMS that draws upon the philosophical underpinnings discussed in the following section.

A philosophy underpinning expert professional practice

In contrast to behavioural approaches (e.g., Cushion, Ford, and Williams 2012), recent sport psychology (Martindale and Collins 2013) and coaching (Collins and Collins 2017) research has recognised and begun to reveal the important cognitive mechanisms that underpin such behaviours of expert practitioners (i.e., knowing not only 'what' and 'how' but also 'why'). In this regard, a key factor to success is the practitioner's decision-making skill and conceptualisation of their working environment. Notably, building on notions of complexity within individuals and real-world environments, is the necessity to create and, in most cases, adjust actions in response to interacting individual, situational and contextual demands (Mees et al. 2020). Therefore, applied practitioners must adopt an idiosyncratic perspective when working to support individuals (Glazier and Mehdizadeh 2019). Indeed, while some practice elements might reflect staple solutions across performers, the manner in which this is enacted will be at least subtly different. In short, the potential 'tools' available to the practitioner are neither right nor wrong, effective nor ineffective; what is crucial is that their optimal application requires an understanding of the factors/demands on which its effect depend. Empirically, this approach is supported by cross-disciplinary evidence that demonstrates inter-individual differences (e.g., Dicks et al. 2017; Pickering and Kiely 2018), is now increasingly recognised within fundamental science research (Pacheco and Newell 2018) and, has already been requested within practitioner accreditation programs (Collins et al. 2015; Martindale and Collins 2013). Philosophically, this *pragmatic* approach is growing within sport psychology and coaching studies, as our understanding of principles have required a sharper and more nuanced interpretation. In fact, pragmatism is a necessity in the quest for stronger translational impact within applied practice (see Coe 2017; Giacobbi Jr. et al., 2005).

Currently, however, much research within DMS appears not to be philosophically oriented towards providing such bespoke understanding of discipline-specific principles which, therefore, presents itself as a perennial problem as research studies have 'built upon' previous findings (Jarvis and Kulig 2020; Jarvis et al. 2020). As such, knowledge is typically underpinned by a thirst for generalisable findings, which permeates methodological approaches (e.g., Dang, Koutedakis, and Wyon 2020; Shan 2005).

This has not always been argued as the best approach however, even within the parent domain of sport and exercise science where DMS originates. Unfortunately, such views have not always been welcomed, or at least adopted, within sport and exercise science, but we wish not to take away from these authors' fundamental contributions to the field. Specifically, we are influenced by a long-stated opinion that research within applied domains should work to deliver both process- (e.g., understanding of information-processing mechanisms) *and* outcome (e.g., did the performance improve)-oriented investigations (cf. Christina 1987). So, evidence to best address the challenges of those who will use it and, by implication, their required outcomes. Collins and Kamin (2012) would distinguish this type of motivation as research *for* a domain (e.g., dance biomechanics with the intention to enhance performance) as opposed to *through* a domain (e.g., biomechanical studies using a dance-like task). It is from this pragmatic position and historical stance that we critically appraise research design in DMS. Specifically, we wish to illuminate some required changes that will redress the balance of our fundamental versus applied knowledge-base and, therefore, improve potential transferability.

Study design characteristics

In this section, we present discrete study characteristics for the purpose of simplicity. However, these characteristics could interact as confounding variables within a single study's methodology and therefore impact on the findings.

Participants

As with *any* empirical DMS study, all require the collection of data from participants. Notably, we identify two prominent issues when attempting to understand the specialist training and level of dancers recruited. Firstly, studies appear too vague in defining the specialist training of participants. For example, participants have been referred to simply as 'dancers' (Rein et al. 2011), homogeneously as 'dancers and/or dance practitioners' (Lampe et al. 2019b), 'sport dancers' (Pilch et al. 2017) which, by definition does not characterise the dance type since any dance can be made competitive. Additionally, many studies often use 'non-dancer' control groups without probing general backgrounds to know if other activities might have a positively transferable impact (e.g., gymnastics or capoeira martial art; Bobrownicki et al. 2021). Finally, even when specialisms are reported, authors have used a combination within the same group and without providing a breakdown of each's makeup (e.g., classical or modern; De Bartolomeo et al. 2007; Lampe et al. 2019a).

Secondly, there is a lack of consensus towards what constitutes different participation standards within DMS. Examples include terminology such as 'recreational' (Krzyzanowicz et al. 2019), 'elite' (Metsios et al. 2020), 'professional' (Jacobs et al.

2017), 'concert' (Thomson, Kibarska, and Jaque 2011), 'experienced' (Lin et al. 2013), 'pre-professional' (Ekegren, Quested, and Brodrick 2014), 'semi-professional' (Lampe et al. 2019b) and 'collegiate' (Gerbino, Griffin, and Zurakowski 2007) dancers. From a pragmatic perspective, these criteria could be usefully supplemented by additional information (e.g., level of company, role) to assess the extent to which the participants were 'elite' by current industry standards. Relatedly when defining participant skill level, studies also report a number of years' experience as a criterion. In a study by Rowley et al. (2015), for example, participants were described with over 5 years' experience of formal dance training, were currently participating in a collegiate dance programme, or were employed as dancers or teachers in the past year and, currently trained at a high level. However, this does not explain what constitutes a 'high level', whether they train full or part-time, nor the level or style of training that these 5 years include; for instance, does this include years during skill acquisition (cf. Schack and Bar-Eli 2007)? For clarity, a dance teacher would be eligible in this study with 10 years of professional performance experience that ended 15 years ago, having recently been employed to teach dance classes to beginners within a community setting. Finally, it is unclear whether the 'dance technique' that is being tested corresponds to the dance training and/or current performance engaged in by participants. In short, criteria for defining participation standard is clearly very complex. Therefore, DMS may wish to consider how participants are portrayed to enable better comparison across datasets and application within real-world practice (Firestone 1993; Lincoln and Guba 1985; Swann, Moran, and Piggott 2015).

Experimental task requirements

Another impactful consideration is the influence of participant experience with a specific dance genre and/or technique which is recognised as affecting a dancer's body (Morris 2003). This is particularly evident in studies conducted *through* dance where a uniform test or movement is required, but is differentially meaningful across participants (e.g., Carter, Bryant, and Hopper 2019). An example of this can be seen when instructing ballet and jazz dancers to execute a *saut de chat* leap (Jarvis and Kulig 2020). Here, according to the ballet code, dancers must execute with externally rotated lower limbs from start to finish of the leap, from the preparatory lead-in steps to take-off, flight and landing (Glasstone 2001). Although jazz dancers are trained to execute through these stages from a parallel or neutrally aligned take-off foot (i.e., in the global sagittal plane), they may externally rotate the limbs *during* the flight stage to achieve and display a greater range of movement, however they will land in the neutral/parallel alignment (Wydro 1981). In this case, it would be important to specify how the technique must be executed, although we would still argue that mixing dancers from two genres is *still* potentially problematic.

Even when different participants *can* execute correctly, the less familiar and less practiced movement for some dancers could result in different motor control strategies governing that execution (Carson and Collins 2016a). Such changes are typically driven by a mismatch between the requested and already well-established movement representation, leading to a higher cognitive demand (i.e., a focus on either more or lesser-established movement components; Paris-Alemany et al. 2019). From a practical

perspective, identifying an appropriate/task-relevant focus in meaningfully novel situations could confuse and/or frustrate the performer (e.g., Bortoli et al. 2012). Therefore, in studies that are characterised by our above example, it may be beneficial for any warm-up /preparatory procedures to incorporate the same technique instructions as during experimental conditions (cf. Wulf and Su 2007). Consequently, time to warm-up and prepare for the two execution conditions could minimise any detrimental differences in neurocognitive co-ordination. Indeed, empirical study has demonstrated that even very subtle and correctly executed differences changes the co-variation of movement structures (Carson, Collins, and Richards 2014) as well as muscle activity and tendomuscular stiffness (Leukel et al. 2012). Certainly, different lower-limb alignment techniques (i.e., neutral vs. externally rotated) have shown kinetic differences within classical ballet jumps (Imura and Iino 2017).

Participant instructions

Equally, the impact of experimental instructions is likely to interact across various internal systems (e.g., biomechanical and motor control processes; Wulf 2013). Keeping with the examples above, the nature of the task could lead to greater cognitive demand, but *also* the type of instructions can lead to suboptimal use of cognitive resources, even if the demand is kept consistent. For example, asking professional classical ballet dancers, academy and conservatoire dancers to execute a *grande jeté* leap by performing 'a galloping preparatory step and takeoff with their preferred leg and extending the opposite limb to achieve a 180° ±5° angle in the air' (Blanco et al. 2019, 3), does not reflect the way in which these movements might be taught or best planned as skills by classical ballet teachers, or by individual dancers (see also Teixeira da Silva et al., 2017). Instead of providing a mechanical explanation of the movement (Giblin et al. 2015), a teacher might identify the body shape in the air, describe the movement using single action-oriented words, such as 'extend' or 'split' in order to emphasise an aesthetic intention. Indeed, representing movements non-verbally, or accessing through short action-oriented words, can facilitate a quicker and more accurate memory retrieval process (e.g., Paivio 1986). For what is a comparatively straight-forward skill at the professional level, executing with an external focus of attention might also facilitate an optimal execution (e.g., jumping over *there*, on *this* shape/path), or even an external followed by internal focus of attention *if* the focus was towards action-appropriate propositions (e.g., on the holistic proprioceptive 'feel'; Montero 2006). Put simply, removing the aesthetic intention limits the evidence for use by dance practitioners due to not appreciating the completeness of the skill; that is, a skill is not *only* technique (Knapp 1963).

Research insights and impact

Finally, reflecting the extent to which studies in DMS offer a truly translational impact within the performance setting, we note that many studies offer recommendations and/or insight that could be considered to represent already-known advice or, dare we say, common sense to the dance practitioner. For example, Aquino et al. (2019) investigated the impact of footwear in relation to possible injury mechanisms in classical ballet (see

also Fong Yan et al. 2011). Based on their findings it was stated that using worn-out pointe shoes to execute *relevé* and *arabesque* techniques resulted in greater lower limb muscular demand when compared to new pointe shoes. At best, this study presents EMG data to specify which muscles activate differently, thus advancing the study of biomechanics *through* dance, with the recommendations having very little impact *for* dance. Another issue is that research often falls short of addressing important criteria within the performance setting, therefore providing an incomplete translation for practitioners. For example, Abergel, Tuesta, and Jarvis (2020) positively set out to replicate dance technique execution under similar levels of effort and intensity as experienced during a professional performance. Findings were reported to show 'less desirable movement patterns' (as determined using multiple lower limb kinematics) and reduced ground reaction forces upon landing when performing multiple *saute* jumps after 5 minutes of dancing to fatigue. Recommendations from this study were that improved endurance and eccentric strength would benefit these dancers, despite acknowledging that such (in many cases miniscule) differences may reflect an attempt to maintain aesthetic performance qualities. Despite this seemingly applied discussion, we cannot reconcile the sole use of quantitative movement analysis to evaluate the impact of fatigue in a study that claims to be motivated towards informing performance. In other words, the incomplete translation of findings may have been addressed by the vital inclusion of 'desirable' or aesthetic movement qualities as viewed by an (expert) audience or the dancers themselves.

Exemplar 'New Moves' for applied research in dance medicine and science

Reflecting these applied considerations, a pragmatic approach will address, inform and develop real-world practices to overcome real-world problems. Accordingly, we highlight a common but scarcely addressed challenge to professional and/or experienced dancers (Liederbach 2010; Vintere and Poulson 2010); that of making a small refinement/tweak/polish to an already long-practiced, learnt and well-automatised movement (Carson and Collins 2011). While there is a predominant focus on injury, injury prevention and/or rehabilitation within the literature (e.g., Boeding et al. 2019; Malone & Hardaker Jr, 1990; Vera et al. 2020), this has insufficiently addressed and/or ignored how these processes are, or can be when required, embedded within a wider plan for effective technical development/progression. In short, injury *is* important for the DMS practitioner, but we suggest that it is too narrow in being able to deliver on many other pertinent and associated applied outcomes. Namely, these would include – when technique refinement was deemed *also* necessary to avoid or recover from injury – newly refined, safe and long-term permanent kinematics that persist under future physical and/or mental stress. By contrast with the extant literature, it should be evident that studies, even when examining changes in dancers' mechanics, have not explicitly addressed these important applied criteria. Perhaps this is unsurprising when considering their more positivistic and mono-disciplinary underpinnings. We are not discrediting this philosophical perspective *per se*; however, we merely highlight the different avenues for research, possible outcomes desired and, therefore, manipulations and measures employed when considering the proposed 'new (pragmatic) moves' to help accelerate research into practice (i.e., research *for* dance; Collins and Kamin 2012). Notably, such an approach would sensibly employ multiple methodologies with the addition of qualitative data to further enhance our

understanding beyond measuring 'what happened' and getting closer to a deeper, interdisciplinary perspective to explain 'why' (Barnard and deLahunta 2017; Goldberg 2020; Mitchell and Clements 2021).

Positively, this endeavour can build upon an applied model, measures and case exemplars within the sport science domain (Carson and Collins 2011, 2014, 2015, 2016b, 2017; Carson, Collins, and Jones 2014; Carson, Collins, and Kearney 2017; Carson, Collins, and Richards 2014, 2016; Collins, Morriss, and Trower 1999; Hanin et al. 2002; Hanin, Malvela, and Hanina 2004). What is needed now within DMS is to understand, tailor and apply these to meet the domain's and performance-specific demands. In fact, we anticipate that a better understanding of skill refinement in dance will benefit beyond the injury context; for example, adapting to a specific and less-familiar choreographic style, confronting different environmental conditions, dancing with a new partner, joining a new company or even as a necessary process to maturation across the lifespan. There is already work within DMS to promote interdisciplinary knowledge and we see addressing this need as a useful extension and addition to that (see Liederbach 2010).

Conclusion

To conclude, we have identified and critically appraised factors within exemplar DMS research that we feel, as practitioners, need to be reconceptualised to enhance the potential translational flow from the laboratory to the dance studio. By adopting a pragmatic philosophy, a different evaluation of studies is afforded, as relevant to real-world challenges faced in dance. Specifically, we have exemplified the essential requirement to consider the interaction between the individual, context and situational demands; thus demonstrating the importance of a practitioner's decision-making skill as a reflection of the complex dance environment. Indeed, it is only through this lens that we see research being able to quickly and optimally enhance existing practice. In an effort to exemplify how this lens can inform research aims and study designs, we suggested a new direction and balance of inquiry that develops current interest in technique within DMS. In our opinion, future research in this professional context should seek to embed interventions within performer's broader pathway and cater for representative outcomes that would be desired by them and their employers.

Finally, in enacting these new moves, we encourage collaboration between practitioners and academics to fully appreciate what would constitute worthwhile applied research. For optimal impact, the difficult task of conducting truly interdisciplinary research will be inevitable and, therefore, require expertise across disciplines and methodologies in this area. Hopefully our brief comments will provide a stimulus for further discussion, planning and future action.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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References

Abergel, R. E., E. Tuesta, and D. N. Jarvis. 2020. "The Effects of Acute Physical Fatigue on Sauté Jump Biomechanics in Dancers." *Journal of Sports Sciences*. Advance online publication. doi:10.1080/02640414.2020.1854425.

Amorim, T., M. Wyon, J. Maia, J. C. Machado, F. Marques, G. S. Metsios, A. D. Flouris, and Y. Koutedakis. 2015. "Prevalence of Low Bone Mineral Density in Female Dancers." *Sports Medicine* 45 (2): 257–268. doi:10.1007/s40279-014-0268-5.

Aquino, J., T. Amasay, S. Shapiro, Y.-T. Kuo, and J. P. Ambegaonkar. 2019. "Lower Extremity Biomechanics and Muscle Activity Differ between 'New' and 'Dead' Pointe Shoes in Professional Ballet Dancers." *Sports Biomechanics* 20 (4): 469–480. doi:10.1080/14763141.2018.1561931. Advance online publication.

Barnard, P., and S. deLahunta. 2017. "Mapping the Audit Traces of Interdisciplinary Collaboration: Bridging and Blending between Choreography and Cognitive Science." *Interdisciplinary Science Reviews* 42 (4): 359–380. doi:10.1080/03080188.2017.1381226.

Blanco, P., S. Nimphius, L. B. Seitz, T. Spiteri, and G. G. Haff. 2019. "Countermovement Jump and Drop Jump Performances are Related to Grand Jeté Leap Performance in Dancers with Different Skill Levels." *The Journal of Strength & Conditioning Research, Publish Ahead of Print*. doi:10.1519/jsc.0000000000003315.

Bobrownicki, R., H. J. Carson, A. C. MacPherson, and D. Collins. 2021. "Unloading the Dice: Comparison-group Design for Improving Translational Impact." International Journal of Sport and Exercise Psychology doi:10.1080/1612197X.2021.1956567. .

Boeding, J. R. E., E. Visser, D. E. Meuffels, and R.-J. de Vos. 2019. "Is Training Load Associated with Symptoms of Overuse Injury in Dancers? A Prospective Observational Study." *Journal of Dance Medicine & Science* 23 (1): 11–16. doi:10.12678/1089-313X.23.1.11.

Bortoli, L., M. Bertollo, Y. Hanin, and C. Robazza. 2012. "Striving for Excellence: A Multi-action Plan Intervention Model for Shooters." *Psychology of Sport and Exercise* 13 (5): 693–701. doi:10.1016/j.psychsport.2012.04.006.

Brennan, M. A. 1986. "A Look Ahead: Dance Research Needed." *Journal of Physical Education, Recreation & Dance* 57 (5): 49–53. doi:10.1080/07303084.1986.10606132.

Carson, H. J., and D. Collins. 2011. "Refining and Regaining Skills in Fixation/diversification Stage Performers: The Five-A Model." *International Review of Sport and Exercise Psychology* 4 (2): 146–167. doi:10.1080/1750984x.2011.613682.

Carson, H. J., and D. Collins. 2014. "Effective Skill Refinement: Focusing on Process to Ensure Outcome." *Central European Journal of Sport Sciences and Medicine* 7 (3): 5–21.

Carson, H. J., and D. Collins. 2015. "Tracking Technical Refinement in Elite Performers: The Good, the Better, and the Ugly." *International Journal of Golf Science* 4 (1): 67–87. doi:10.1123/ijgs.2015-0003.

Carson, H. J., and D. Collins. 2016a. "The Fourth Dimension: A Motoric Perspective on the Anxiety–performance Relationship." *International Review of Sport and Exercise Psychology* 9 (1): 1–21. doi:10.1080/1750984X.2015.1072231.

Carson, H. J., and D. Collins. 2016b. "Implementing the Five-A Model of Technical Change: Key Roles for the Sport Psychologist." *Journal of Applied Sport Psychology* 28 (4): 392–409. doi:10.1080/10413200.2016.1162224.

Carson, H. J., and D. Collins. 2017. "Refining Motor Skills in Golf: A Biopsychosocial Perspective." In *Routledge International Handbook of Golf Science*, edited by M. Toms, 196–206, Routledge.

Carson, H. J., D. Collins, and B. Jones. 2014. "A Case Study of Technical Change and Rehabilitation: Intervention Design and Interdisciplinary Team Interaction." *International Journal of Sport Psychology* 45 (1): 57–78. doi:10.7352/IJSP2014.45.057.

Carson, H. J., D. Collins, and P. Kearney. 2017. "Skill Change in Elite-level Kickers: Interdisciplinary Considerations of an Applied Framework." In *Football Biomechanics*, edited by H. Hiroyuki, E. Hennig, and N. Smith, 173–189, Routledge.

Carson, H. J., D. Collins, and J. Richards. 2014. "Intra-individual Movement Variability during Skill Transitions: A Useful Marker?" *European Journal of Sport Science* 14 (4): 327–336. doi:10.1080/17461391.2013.814714.

Carson, H. J., D. Collins, and J. Richards. 2016. "Initiating Technical Refinements in High-level Golfers: Evidence for Contradictory Procedures." *European Journal of Sport Science* 16 (4): 473–482. doi:10.1080/17461391.2015.1092586.

Carter, S. L., A. R. Bryant, and L. S. Hopper. 2019. "An Analysis of the Foot in Turnout Using a Dance Specific 3D Multi-segment Foot Model." *Journal of Foot and Ankle Research* 12 (1): 10. doi:10.1186/s13047-019-0318-1.

Christina, R. W. 1987. "Motor Learning: Future Lines of Research." In *The Cutting Edge in Physical Education and Exercise Science Research*, edited by M. J. Safrit and H. M. Eckert, 26–41, Human Kinetics.

Coe, R. J. 2017. "The Nature of Educational Research." In *Research Methods and Methodologies in Education*. 2nd ed.ed., edited by R. Coe, M. Waring, L. V. Hedges, and J. Arthur, 5–14. Sage.

Collins, D., V. Burke, A. Martindale, and A. Cruickshank. 2015. "The Illusion of Competency versus the Desirability of Expertise: Seeking a Common Standard for Support Professions in Sport." *Sports Medicine* 45 (1): 1–7. doi:10.1007/s40279-014-0251-1.

Collins, L., and D. Collins. 2017. "The Foci of In-action Professional Judgement and Decision-making in High-level Adventure Sports Coaching Practice." *Journal of Adventure Education and Outdoor Learning* 17 (2): 122–132. doi:10.1080/14729679.2016.1227717.

Collins, D., and S. Kamin. 2012. "The Performance Coach." In *The Oxford Handbook of Sport and Performance Psychology*, edited by S. M. Murphy, 692–706, Oxford University Press.

Collins, D., C. Morriss, and J. Trower. 1999. "Getting It Back: A Case Study of Skill Recovery in an Elite Athlete." *The Sport Psychologist* 13 (3): 288–298. doi:10.1123/tsp.13.3.288.

Collins, L., S. Simon, and H. J. Carson. 2019. "Para-adventure: A Hyper-dynamic Problem for the Inclusive Coach." *Sport in Society* 22 (7): 1165–1182. doi:10.1080/17430437.2018.1504776.

Cushion, C., P. R. Ford, and A. M. Williams. 2012. "Coach Behaviours and Practice Structures in Youth Soccer: Implications for Talent Development." *Journal of Sports Sciences* 30 (15): 1631–1641. doi:10.1080/02640414.2012.721930.

Dang, Y., Y. Koutedakis, and M. Wyon. 2020. "Fit to Dance Survey: Elements of Lifestyle and Injury Incidence in Chinese Dancers." *Miedical Problems of Performing Artists* 35 (1): 10–18. doi:10.21091/mppa.2020.1002.

De Bartolomeo, O., M. M. Sette, J. Vander Sloten, and W. Albisetti. 2007. "Electromyographic Study on the Biomechanics of the Lower Limb during the Execution of Technical Fundamentals of Dance: The Relevè." *Journal of Biomechanics* 40: S789. doi:10.1016/S0021-9290(07)70777-7.

Dicks, M., C. Button, K. Davids, J. Y. Chow, and J. van der Kamp. 2017. "Keeping an Eye on Noisy Movements: On Different Approaches to Perceptual-motor Skill Research and Training." *Sports Medicine* 47 (4): 575–581. doi:10.1007/s40279-016-0600-3.

Ekegren, C. L., R. Quested, and A. Brodrick. 2014. "Injuries in Pre-professional Ballet Dancers: Incidence, Characteristics and Consequences." *Journal of Science and Medicine in Sport* 17 (3): 271–275. doi:10.1016/j.jsams.2013.07.013.

Firestone, W. A. 1993. "Alternative Arguments for Generalizing from Data as Applied to Qualitative Research." *Educational Researcher* 22 (4): 16–23. doi:10.3102/0013189X022004016.

Fong Yan, A., S. Cobley, C. Chan, E. Pappas, L. L. Nicholson, R. E. Ward, R. E. Murdoch, et al. 2018. "The Effectiveness of Dance Interventions on Physical Health Outcomes Compared to Other Forms of Physical Activity: A Systematic Review and Meta-analysis." *Sports Medicine* 48 (4): 933–951. doi:10.1007/s40279-017-0853-5.

Fong Yan, A., C. Hiller, R. Smith, and B. Vanwanseele. 2011. "Effect of Footwear on Dancers: A Systematic Review." *Journal of Dance Medicine & Science* 15 (2): 86–92.

Gerbino, P. G., E. D. Griffin, and D. Zurakowski. 2007. "Comparison of Standing Balance between Female Collegiate Dancers and Soccer Players." *Gait & Posture* 26 (4): 501–507. doi:10.1016/j.gaitpost.2006.11.205.

Giacobbi, J, P., R. Poczwardowski, A, and P. Hager. 2005. "A Pragmatic Research Philosophy for Applied Sport Psychology." *The Sport Psychologist* 19 (1): 18–31. doi:10.1123/tsp.19.1.18.

Giblin, G., D. Farrow, M. Reid, K. Ball, and B. Abernethy. 2015. "Exploring the Kinaesthetic Sensitivity of Skilled Performers for Implementing Movement Instructions." *Human Movement Science* 41: 76–91. doi:10.1016/j.humov.2015.02.006.

Glasstone, R. 2001. *Classical Ballet Terms: An Illustrated Dictionary*. Princeton Book Co Pub.

Glazier, P. S., and S. Mehdizadeh. 2019. "Challenging Conventional Paradigms in Applied Sports Biomechanics Research." *Sports Medicine* 49 (2): 171–176. doi:10.1007/s40279-018-1030-1.

Goldberg, T. A. 2020. *Trends and Traditions: A Mixed Methods Study of Tap Dance Education in the Private Sector Dance Studio*. Doctoral), Lesley University. Retrieved from. https://digitalcommons.lesley.edu/education_dissertations/166

Hanin, Y., T. Korjus, P. Jouste, and P. Baxter. 2002. "Rapid Technique Correction Using Old Way/new Way: Two Case Studies with Olympic Athletes." *The Sport Psychologist* 16 (1): 79–99. doi:10.1123/tsp.16.1.79.

Hanin, Y., M. Malvela, and M. Hanina. 2004. "Rapid Correction of Start Technique in an Olympic-level Swimmer: A Case Study Using Old Way/new Way." *Journal of Swimming Research* 16 (1): 11–17.

Imura, A., and Y. Iino. 2017. "Comparison of Lower Limb Kinetics during Vertical Jumps in Turnout and Neutral Foot Positions by Classical Ballet Dancers." *Sports Biomechanics* 16 (1): 87–101. doi:10.1080/14763141.2016.1205122.

Jacobs, C. L., J. D. Cassidy, P. Côté, E. Boyle, E. Ramel, C. Ammendolia, J. Hartvigsen, and I. Schwartz. 2017. "Musculoskeletal Injury in Professional Dancers: Prevalence and Associated Factors: An International Cross-sectional Study." *Clinical Journal of Sport Medicine* 27 (2): 153–160. doi:10.1097/JSM.0000000000000314.

Jarvis, D. N., and K. Kulig. 2020. "What Goes up Must Come Down: Consequences of Jump Strategy Modification on Dance Leap Take-off Biomechanics." *Journal of Sports Sciences* 38 (16): 1836–1843. doi:10.1080/02640414.2020.1756710.

Jarvis, D. N., S. M. Sigward, K. Lerch, and K. Kulig. 2020. "What Goes up Must Come Down, Part II: Consequences of Jump Strategy Modification on Dance Leap Landing Biomechanics." *Journal of Sports Sciences* 1–7. doi:10.1080/02640414.2020.1825059.

Knapp, B. 1963. *Skill in Sport: The Attainment of Proficiency*. Routledge & Keegan Paul.

Koutedakis, Y., and A. Jamurtas. 2004. "The Dancer as a Performing Athlete." *Sports Medicine* 34 (10): 651–661. doi:10.2165/00007256-200434100-00003.

Krzyzanowicz, R., F. Gargano, J. May, and A. Nasypany. 2019. "Analysis of Patient Outcomes When Applying the Mulligan Concept to Treat Recreational Dancers with Patellofemoral Pain Syndrome." *Physical Medicine and Rehabilitation Science* 1 (1): 100001.

Lampe, J., D. A. Groneberg, B. Borgetto, D. Ohlendorf, and E. M. Wanke. 2019a. "Assessment of Musculoskeletal Pain in Dance Focusing on Dance-style Related Differences." *The Physician and Sportsmedicine* 47 (4): 433–440. doi:10.1080/00913847.2019.1613120.

Lampe, J., D. Ohlendorf, D. A. Groneberg, B. M. Borgetto, and E. M. Wanke. 2019b. "Muskuloskelettale Schmerzen Im Tanz: Prävalenz, Lokalisationen Und Zeitlicher Verlauf Bei Tänzerinnen Mit Amateurstatus Und Ihren Hauptberuflich Tätigen Lehrkräften [Musculoskeletal Pain in Dance: Prevalence, Localisation and Development over Time in Amateur Dancers and Professional Dance Teachers]." *Sportverletz Sportschaden* 33 (4): 203–211. doi:10.1055/a-0729-9239.

Leukel, C., W. Taube, M. Lorch, and A. Gollhofer. 2012. "Changes in Predictive Motor Control in Drop-jumps Based on Uncertainties in Task Execution." *Human Movement Science* 31 (1): 152–160. doi:10.1016/j.humov.2011.04.006.

Liederbach, M. 2010. "Perspectives on Dance Science Rehabilitation Understanding Whole Body Mechanics and Four Key Principles of Motor Control as a Basis for Healthy Movement." *Journal of Dance Medicine & Science* 14 (3): 114–124.

Lin, C.-W., F.-C. Su, H.-W. Wu, and C.-F. Lin. 2013. "Effects of Leg Dominance on Performance of Ballet Turns (Pirouettes) by Experienced and Novice Dancers." *Journal of Sports Sciences* 31 (16): 1781–1788. doi:10.1080/02640414.2013.803585.

Lincoln, Y. S., and E. G. Guba. 1985. *Naturalistic Inquiry*. Sage.
Malone, T. R., and J. W. T. Hardaker. 1990. "Rehabilitation of Foot and Ankle Injuries in Ballet Dancers." *Journal of Orthopaedic & Sports Physical Therapy* 11 (8): 355–361. doi:10.2519/jospt.1990.11.8.355.
Martindale, A., and D. Collins. 2013. "The Development of Professional Judgment and Decision Making Expertise in Applied Sport Psychology." *The Sport Psychologist* 27 (4): 390–399. doi:10.1123/tsp.27.4.390.
Mees, A., D. Sinfield, D. Collins, and L. Collins. 2020. "Adaptive Expertise – A Characteristic of Expertise in Outdoor Instructors?" *Physical Education and Sport Pedagogy* 25 (4): 423–438. doi:10.1080/17408989.2020.1727870.
Metsios, G. S., M. Wyon, K. Patel, N. Allen, and Y. Koutedakis. 2020. "Dancers' Heart: Cardiac Screening in Elite Dancers." *European Journal of Sport Science* 20 (7): 920–925. doi:10.1080/17461391.2019.1672793.
Mitchell, S. B., and L. Clements. 2021. "Psychosocial, Physical, and Cognitive Perspectives on the Adolescent Dancer." In *Scientific Perspectives and Emerging Developments in Dance and the Performing Arts*, edited by B. Pessali-Marques, 69–93, IGI Global.
Montero, B. 2006. "Proprioception as an Aesthetic Sense." *The Journal of Aesthetics and Art Criticism* 64 (2): 231–242. doi:10.1111/j.0021-8529.2006.00244.x.
Morris, G. 2003. "Problems with Ballet: Steps, Style and Training." *Research in Dance Education* 4 (1): 17–30. doi:10.1080/14647890308308.
Pacheco, M. M., and K. M. Newell. 2018. "Transfer of a Learned Coordination Function: Specific, Individual and Generalizable." *Human Movement Science* 59: 66–80. doi:10.1016/j.humov.2018.03.019.
Paivio, A. 1986. *Mental Representations: A Dual-coding Approach*. Oxford University Press.
Paris-Alemany, A., R. La Touche, L. Gadea-Mateos, F. Cuenca-Martínez, and L. Suso-Martí. 2019. "Familiarity and Complexity of A Movement Influences Motor Imagery in Dancers: A Cross-sectional Study." *Scandinavian Journal of Medicine and Science in Sports* 29 (6): 897–906. doi:10.1111/sms.13399.
Pickering, C., and J. Kiely. 2018. "Are the Current Guidelines on Caffeine Use in Sport Optimal for Everyone? Inter-individual Variation in Caffeine Ergogenicity, and a Move Towards Personalised Sports Nutrition." *Sports Medicine* 48 (1): 7–16. doi:10.1007/s40279-017-0776-1.
Pilch, W., Ł. Tota, I. Pokora, M. Głowa, A. Piotrowska, O. Chlipalska, R. Zuziak, and O. Czerwińska. 2017. "Energy Expenditure and Lactate Concentration in Sports Dancers in a Simulated Final Round of the Standard Style Competition." *Human Movement* 18 (2): 62–67. doi:10.1515/humo-2017-0012.
Rein, S., T. Fabian, H. Zwipp, S. Rammelt, and S. Weindel. 2011. "Postural Control and Functional Ankle Stability in Professional and Amateur Dancers." *Clinical Neurophysiology* 122 (8): 1602–1610. doi:10.1016/j.clinph.2011.01.004.
Rowley, K. M., D. N. Jarvis, T. Kurihara, Y.-J. Chang, A. L. Fietzer, and K. Kulig. 2015. "Toe Flexor Strength, Flexibility and Function and Flexor Hallucis Longus Tendon Morphology in Dancers and Non-dancers." *Medical Problems of Performing Artists* 30 (3): 152–156. doi:10.21091/mppa.2015.3029.
Ruscello, B., M. Esposito, L. Pantanella, F. Partipilo, L. Lunetta, and S. D'Ottavio. 2018. "Biomechanics and Physiology in Top Level Pole Dancers. A Case Study." *Journal of Physical Health and Sports Medicine* 1 (1): 1–15. doi:10.36811/jphsm.2019.110001.
Schack, T., and M. Bar-Eli. 2007. "Psychological Factors of Technical Preparation." In *Psychology of Sport Training*, edited by B. Blumenstein, R. Lidor, and G. Tenenbaum, 62–103, Meyer & Meyer Sport.
Shan, G. 2005. "Comparison of Repetitive Movements between Ballet Dancers and Martial Artists: Risk Assessment of Muscle Overuse Injuries and Prevention Strategies." *Research in Sports Medicine* 13 (1): 63–76. doi:10.1080/15438620590922103.
Swann, C., A. Moran, and D. Piggott. 2015. "Defining Elite Athletes: Issues in the Study of Expert Performance in Sport Psychology." *Psychology of Sport and Exercise* 16 (1): 3–14. doi:10.1016/j.psychsport.2014.07.004.

Teixeira, D. S., M. Thofehrn Lessa, H, and S. Chiviacowsky. 2017. "External Focus of Attention Enhances Children's Learning of a Classical Ballet Pirouette." *Journal of Dance Medicine & Science* 21 (4): 179–184. doi:10.12678/1089-313X.21.4.179.

Thomson, P., L. A. Kibarska, and S. V. Jaque. 2011. "Comparison of Dissociative Experiences between Rhythmic Gymnasts and Female Dancers." *International Journal of Sport and Exercise Psychology* 9 (3): 238–250. doi:10.1080/1612197X.2011.614850.

Vera, A. M., B. D. Barrera, L. E. Peterson, T. R. Yetter, D. Dong, D. A. Delgado, P. C. McCulloch, K. E. Varner, and J. D. Harris. 2020. "An Injury Prevention Program for Professional Ballet: A Randomized Controlled Investigation." *Orthopaedic Journal of Sports Medicine* 8 (7): 2325967120937643. doi:10.1177/2325967120937643.

Vintere, P., and C. L. Poulson. 2010. "The Effects of a Behavioral Movement-training Package on Dance Performance." *European Journal of Behavior Analysis* 11 (2): 151–166. doi:10.1080/15021149.2010.11434340.

Wilson, M., and Y.-H. Kwon. 2008. "The Role of Biomechanics in Understanding Dance Movement: A Review." *Journal of Dance Medicine & Science* 12 (3): 109–116.

Wulf, G. 2013. "Attentional Focus and Motor Learning: A Review of 15 Years." *International Review of Sport and Exercise Psychology* 6 (1): 77–104. doi:10.1080/1750984x.2012.723728.

Wulf, G., and J. Su. 2007. "An External Focus of Attention Enhances Golf Shot Accuracy in Beginners and Experts." *Research Quarterly for Exercise and Sport* 78 (4): 384–389. doi:10.1080/02701367.2007.10599436.

Wydro, K. 1981. *The Luigi Jazz Dance Technique*. Doubleday Books.

Zaletel, P., and T. Kajtna. 2020. "Motivational Structure of Female and Male Dancers of Different Dance Disciplines." *Acta Gymnica* 50 (2): 68–76. doi:10.5507/ag.2020.010.