Title:

The Goldsmiths Dance Sophistication Index (Gold-DSI): a new psychometric tool to assess individual differences in dance experience.

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Abstract

Dance has become an important topic for research in empirical aesthetics, social and motor cognition, and as an intervention for neurodegenerative and neurodevelopmental disorders. Despite the growing scientific interest in dance, no standardised psychometric instrument exists to assess people's dance experience. Here, we introduce the Goldsmiths Dance Sophistication Index (Gold-DSI), a 26-item questionnaire to measure individual differences in participatory and observational dance experience on a continuous scale. The Gold-DSI was developed in three stages: In the first stage a set of 76 items was generated by adapting questions from the Goldsmiths Musical Sophistication Index (Müllensiefen et al., 2014), and as part of a stakeholder workshop using a grounded theory approach. The second stage focused on item reduction. Using a large-scale online survey (N=424) , hierarchical factor analysis was used to fit a model comprising of one general and six secondary factors (28 items in total). In stage three, six new items were added to specifically capture individual differences in dance observation. We then collected data from two samples for final model estimation (N=127) and evaluation (N=190). The final version of the Gold-DSI comprises 26 items; 20 items relate to one general factor that captures experience in *dance participation*. This includes four secondary factors: Body Awareness, Social Dancing, Urge to Dance, and Dance Training. A further six items separately measure experience in dance observation. In sum, the Gold-DSI provides a brief, standardised and continuous assessment of doing, watching and knowing about dance.

Keywords: Dance, Expertise, Questionnaire, Individual differences, Psychometrics

Introduction

The scientific study of dance has become an increasingly important topic in psychology and cognitive neuroscience. Dance has been applied to study how we perform, perceive, and remember complex whole-body actions (Bläsing et al., 2012; Brown & Parsons, 2008; Christensen, Gaigg, & Calvo-Merino, 2018; Kirsch, Snagg, Heerey, & Cross, 2016; Cross, & Ticini, 2012; Orgs, Calvo-Merino, & Cross, 2018; Stevens, Vincs, Delahunta, & Old, 2019). Dancing has also formed the basis of new therapeutic interventions for a range of psychological and neurological conditions, including Parkinson's disease (Earhart, 2009; Shanahan et al., 2015, 2017; Prado, Hadley & Rose, 2020), dementia (Koch & Fuchs, 2011) and autism (Mateos-Moreno & Atencia-Doña, 2013; Scharoun, Reinders, Bryden & Fletcher, 2014). Moreover, studying dance enables interdisciplinary discourse about the human body between the sciences, the arts and the humanities (Reason et al., 2016). Yet, no standardised psychometric instrument exist to assess individual differences in dance experience. To fill this gap, we developed the Goldsmiths Dance Sophistication Index (Gold-DSI) that distinguishes experience with *doing dance* (participatory dance experience), from experience with *watching* and *knowing about* dance (observational dance experience) in keeping with motor, visual and conceptual sources of dance expertise (Orgs, Calvo-Merino & Cross, 2018).

Research on dance broadly falls into two categories; either studying dance as a *topic* or using it as a *tool*. As a topic**,** dance is relevant to research that investigates how and why humans develop culture and cultural artefacts (Hagen & Bryant, 2003; Lovatt, 2018; Woolhouse, Tidhar, & Cross, 2016). For instance, dance is part of religious and other rituals across all known cultures, and has been argued to play an important role in group formation and communication (Dissanayake, 2017; Hanna, 1987; Vicary, Sperling, von Zimmermann, Richardson, & Orgs, 2017; von Zimmermann, Vicary, Sperling, Orgs, & Richardson, 2018).

As an art form, dance can be described as an ‘aesthetic experience, and a creative process, through which the body, brain and personality combine to express and communicate thoughts and feelings (H’Doubler, 1940). Traditionally however, research in empirical aesthetics and creative cognition have largely focused on the visual arts and music. Only in recent years have scientists begun to study aesthetic and creative cognition in dance more systematically (Christensen & Calvo-Merino, 2013; deLahunta et al., 2018; Giguere, 2011; Kirsch, Urgesi & Cross, 2016; Orgs, Caspersen, & Haggard, 2016; Stevens & Leach, 2015; Stevens, Malloch, McKechnie, & Steven, 2003; Weber, 2016).

As a tool, principles from dance and choreography have been used to study all aspects of human cognition: Dance-based stimuli have been used in research on interoception, emotion perception, selective attention, implicit learning, working memory, creativity and divergent thinking, personality, and motor learning (Bläsing, 2010; Christensen, Gomila, Gaigg, Sivarajah, & Calvo-Merino, 2016; Christensen, Gaigg, & Calvo-Merino, 2018; Fink, Graif, & Naubauer, 2009; Hänggi, Koeneke, Bezzola, & Jäncke, 2010; Karpati, Giacosa, Foster, Penhune, & Hyde, 2015; Lovatt, 2018; Sowden, Clements, Redlich, & Lewis, 2015; Willard & Lavallee, 2016). In particular, studying dance experts has provided a fruitful approach to understanding the neural mechanisms of visual action and body perception (Calvo-Merino et al., 2005, 2006; Cross et al., 2009; Orgs et al., 2008; Orlandi, Zani, & Proverbio, 2017).

Dance is also becoming increasingly important in the context of prevention and treatment of neurodegenerative disorders. For example, regular dancing has been linked to a reduced risk for dementia (Karkou & Meekums, 2017; Verghese et al., 2003), and can improve gait and mood in Parkinson’s disease (Ghai, Ghai, Schmitz, & Effenberg, 2018; Earhart, 2009; Lewis et al., 2016; Lyons et al., 2018; Shanahan et al., 2015; Rose et al., 2019b), as it combines rhythmical movement to music with a socially engaging environment.

For a recent review on dance-based interventions in clinical contexts and their potential neurocognitive mechanisms, see Millman, Terhune, Hunter, & Orgs (2020).

Importantly, any psychological study involving dance should assess people's prior engagement with dance as a source of individual differences between study participants. For example, if regular dancing is indeed linked to lower risk for developing dementia (Verghese et al., 2003), clinical studies on the effectiveness of treatments for dementia should control for the influence of prior dance experience among study participants. To provide such a measure, we introduce the concept of *dance sophistication* to quantify individual differences in both doing dance (dance participation) and watching dance (dance (observation), in loose analogy to the assessment of musical sophistication in the general population (Müllensiefen, Gingras, Musil & Stewart, 2014).

In contrast to the limited scientific literature on individual differences in dance experience, research on musical abilities has a long history in psychology, musicology and educational studies (Bentley, 1966; Gordon, 1989; Seashore, 1919). Yet, these tests of musical ability overlook a variety of musical achievements or skills; being able to verbally communicate about music at a high level, to use music effectively to manipulate the emotional states of one's self and others, and to classify sounds and precisely recognize and categorize features of musical styles (Honing, 2017). To measure musical skills and achievements in a more comprehensive way, Müllensiefen and colleagues (2014) devised the Goldsmiths Musical Sophistication Index (Gold-MSI), a psychometric tool to measure individual differences of musical behaviours in the general population. Focusing on musical sophistication rather than musical expertise acknowledges that musical behaviours are multi-faceted and do not necessarily involve extensive training in playing an instrument. Moreover, the measurement construct of musical sophistication allows a continuous assessment of people's diverse engagement with music on different subscales, and thus avoids a simplistic

binary distinction between musicians and non-musicians. Similarly, we introduce the concept of dance sophistication as a multifaceted and continuous construct of both knowledge and skill (Ericsson, Hoffman, Kozbelt & Williams, 2018; Sternberg, 2018), that differentiates between participatory and observational components of dance experience.

The ***participatory component*** of dance sophistication captures how much and how often someone dances. It encompasses social dancing, as well as formal and informal dance training. Regular dancing should develop visual and sensorimotor expertise (Calvo-Merino et al., 2006), improve memory for learning new movements (Bläsing et al. 2012; Stevens et al., 2019), increase expressive nonverbal communication abilities (Lewis, 2006) and body awareness (Christensen, Gaigg, & Calvo-Merino, 2018). Frequent dancing also improves physical fitness across all ages (Burkhardt & Brennan, 2012; Hwang & Braun, 2015; Koutedakis & Jamurtas, 2004). Moreover, dancing in groups encourages interpersonal interactions and promotes social bonding (Overy & Molnar-Szakacs, 2009; Ravignani & Cook, 2016; Whyatt & Torres, 2017). The extent of a person's participation in dance might therefore relate to a person's sociability (Kreutzmann, Zander & Webster, 2018).

The ***observational component*** of dance sophistication relates to knowledge about, and engagement with dance that does not involve dancing oneself. For example, it encompasses how frequently a person attends dance performances, and how interested someone is in dance and choreography. It also includes knowledge about dance making and choreographic practice including the history of dance as an artform. Research on dance in the context of motor cognition typically focuses on participatory dance experience alone, whilst controlling for the influence of observational dance experience (Calvo-Merino et al., 2010; Kirsch & Cross, 2015). In contrast, research on dance appreciation should require careful assessment of observational dance experience as a predictor of aesthetic judgement, in keeping with the importance of cognitive mastering for visual art appreciation (Leder & Nadal, 2014).

Dance sophistication may relate to specific personality traits as these have been shown to predict a person's engagement with art, in particular 'openness to experience'. Judge, Higgins, Thoresen and Barrick (2006) found that this trait is a predictor for working in the artistic sector and it correlates with a range of measures of creativity. Openness to experience has been shown to be higher in professional dancers than in novices and correlates with increased preference for dance without music (Jola, Pollick, & Calvo-Merino, 2014). More generally, people scoring high on openness to experience enjoy greater complexity and novelty (Fayn, MacCann, Tiliopoulos & Silvia, 2015; Fink, Graif, & Naubauer, 2009). Other studies have also suggested that musicality is linked to openness to experience (Corrigall, Schellenberg, & Misura, 2013; Gibson et al., 2009; Kemp, 1996; Vuoskoski & Eerola, 2011). In relation to the concept of musical sophistication, Greenberg, Müllensiefen, Lamb, & Rentfrow (2015) have shown that higher self-reported musical sophistication is linked to higher openness to experience, and this is equally true of musicians whether they have learned informally, or been formally taught (Rose, Jones Bartoli, & Heaton, 2019a). Therefore, openness to experience may be an important personality trait related to both the participatory and observational components of dance sophistication.

The Gold-DSI was developed in three stages. In Stage 1, a workshop was undertaken with stakeholders in the dance and the dance research community, including professional dancers, dance teachers, choreographers, dance practitioners and dance academics. In this workshop we developed a preliminary set of dimensions of dance sophistication, and generated a pool of items for testing. In Stage 2, we conducting an online study to reduce the number of items and developed a preliminary model of dance sophistication. In Stage 3, two further online studies (new samples) served to finalise the factorial structure of the Gold-DSI and assess validity and reliability of the measure.

Methods

All individual studies were approved by the local ethics committees at the University of Hertfordshire and Goldsmiths, University of London. All participants provided written informed consent prior to the study in accordance with the recommendations of the Helsinki Declaration.

Stage 1 – Item generation

A one-day workshop brought together nine academics and dance professionals from different backgrounds, including musical theatre, ballroom dancing, dance therapy and performing dance (i.e., two choreographers, and one dance teacher, a trainee dance teacher, a dance student, two psychologists with expertise in dance and two psychologists with expertise in music). The agenda for the workshop was based on principles of Grounded Theory (GT; Bryant & Charmaz, 2007; Glaser, 1978; Strauss & Corbin, 1990) and aimed to uncover a stable overall structure of the dance sophistication construct (Charmaz & Belgrave, 2012) and to identify relevant themes (Glaser, 2002).

Stage 1 Method

As an initial task, attendees considered and, where appropriate, re-worded question items from the Gold-MSI in relation to dance (see Appendix A). This process was instigated in order to generate discussions around the concept of dance sophistication prior to specifically addressing the following questions: *'What is dance sophistication?', 'Why do we need a tool to assess it?', 'What information does it need to capture (e.g., dimensions of dance, range of abilities, types of engagement, universals vs style-specific elements of dance)?'.* Following these tasks, attendees generated novel question items based on ideas raised during the discussion about the concept of dance sophistication. All tasks were recorded and later transcribed and analysed by three researchers using GT to compile and edit the pool of question items on which to base the construct of dance sophistication.

Stage 1 Results

All 39 questions from the Gold-MSI were reformulated to apply to dance and the results of the paired work undertaken during the one-day workshop are provided in Appendix A. In response to the question asking what the term 'dance sophistication' might encompass, attendees described twenty-five potential characteristics, which were reduced to five themes and fifteen subthemes using GT analyses, as presented in Table 1. Workshop attendees also provided thirteen suggested reasons for, and ways they would use and apply an instrument that could measure dance sophistication. Following GT coding, these were reduced to five key reasons (see Table 2), mapping onto the five themes from Table 1.

Table 1. *Grounded Theory generated themes and subthemes of dance sophistication.*

	Themes	Subthemes	Reasons for Inclusion
1	Reasons for Engaging with Dance	Motivation to Dance; Urge to Move/Pleasure in Moving/Natural responses to music/others; Context of dancing (groups/intimacy/solitary	Current dance practice (formal/informal), exercise, professional, fun/social, inhibition, accessibility (time and money)
2	General Fitness and Ability	Coordination ability; Athleticism/Fitness/Physicality	Dance Training and Ability, Bodily Awareness,
3	Dance as Art	Structures vs. non-structured (Choreographed vs. improvisation). Aesthetic appeal of dance (watching); Self-expression through dance	Inclination to dance, engage with dance, Attitudes to dance, Affective properties of dance, Association between music and dance
4	Dance Expertise	Amount of dance practice; Present and peak engagement; Dance Training	Training and qualifications, experience, competitions/teaching
5	Creativity and Teaching	Ability to teach/instruct; Ability to imagine/visual/create dance; Ability to judge dance (performance/choreography)	Formal/informal learning, personality

Table 2. *Key reasons to develop a tool for quantifying dance sophistication derived from Grounded Theory.*

Name of Reason	Description of Reason	Link to DSI Theme in Table 1.
Individualize Training	To be able to tailor dance training/lessons for the participants	1, 2, 5
Ensure Diversity	To consider provision in terms of diversity and accessibility	2, 3, 4, 5
Document Development	To enable practitioners to understand how people learn (formally and informally)	1, 2, 5
Evaluate Interventions	To enable evaluation of the efficacy of dance-based interventions for health and wellbeing (i.e., how much does previous dance experience affect outcomes)	1, 2, 3, 4, 5
Understand Audiences	To provide a way to understand audience experience in terms of engagement and expertise	3, 4, 5

Finally, a list of 140 potential questions and statements pertinent to the concept of dance sophistication was compiled from the workshop attendees. In a subsequent step using GT analyss, and thorough screening for redundancy, that initial list was reduced to a pool of 76 questions and statements (see Appendix B) that were grouped and aligned to the five themes forming the concept of dance sophistication (see Table 1). The questions and statements were edited to be useable within a survey inventory by balancing positive and negative statements and adapting items to work with a seven-point agreement scale.

Stage 2 – Item Reduction

The primary aim of Stage 2 was to reduce the large item pool generated in Stage 1 in order to obtain a smaller set of items that still contained suitable dimensional structure. Hence, an online survey was conducted to produce the dataset in this study which only served the purpose of variable selection, while the dataset of the subsequent study (Stage 3) was used for model estimation, evaluation, and validation in order to avoid model overfitting on individual datasets.

Stage 2 – Method

Participants

After excluding participants that completed less than 50% of the survey questions, 424 participants with a mean age of 33.4 years (SD = 13.4) remained in the sample. Most of the participants were female (80%), half (54%) were in full time or part time employment, 23% were at university, 10% were self-employed, and the remaining 13% were unemployed, at school or retired.

Materials

In addition to the 76 items asking for different aspects of dance sophistication generated in Study 1, the online survey contained four questions on the demographic background of participants (as used in the Gold-MSI). The survey was implemented through the Qualtrics (Provo, Utah) online survey platform.

Procedure

To reach a large audience an online questionnaire was set up and promoted through a variety of different channels, including promotion through radio features, social media contacts, and a dedicated YouTube video. Participants were offered the chance to be included in a prize draw to win a Samsung Galaxy tablet. Participants were directed to the survey's landing site and gave their consent for participating in the study after being briefed about its content. All data was collected anonymously.

Stage 2 – Results

The purpose of the data analysis of Stage 2 was to identify the factorial dimensions and reduce the number of items, following an exploratory factor analysis strategy similar to the one described by Fancourt, Garnett, Spiro, West and Müllensiefen (2019). Twelve variables with skewness or kurtosis > +/- 2 were excluded. Subsequently, the hierarchical omega coefficient was computed for the set of remaining variables using the function *omega*

from the R package psych (Revelle, 2018) which yielded a value of 0.69. According to the guidelines given by McDonald (2013) hierarchical omega values > 0.6 indicate the presence of a general factor. Therefore, a series of hierarchical factor models (minimum residual factoring with oblimin rotation) were computed where each model contained a general factor and between three and 10 secondary group factors (i.e., so-called Schmid-Leiman models).

Models were compared on the Bayesian Information Criterion and a model with six secondary group factors had the best model fit (the difference in BIC values to next best model was 11.2, and therefore substantial). In order to the reduce the number of items further we selected only those 33 items with a communality of h > = 0.5 and ran the model comparison step again. The model, again with six secondary group factors, showed again the best model fit (BIC difference to second best model was 15.9).

Finally, in order to obtain a simple factorial structure where each item has a strong loading only on one group factor and low loadings on all other group factors, we excluded five further items where the ratio of the loading of the strongest group factor to the loading on the second strongest group factor was > = 1.5. This resulted in a final set of 28 items in the model, consisting of one primary (Participatory Dance Experience) and six secondary factors. The six factors in this preliminary DSI model were interpreted as 1. Predilection/Social Anxiety, 2. Embodied Awareness, 3. Past Dance Training, 4. Dedication to Dance, 5. Present Dance Training, and 6. Urge to Dance.

Stage 2 – Discussion

Data reduction (i.e., variable selection) was successful because the number of items was reduced from 76 to 28, all with strong intercorrelations with other variables. In addition, the factor model had a simple factorial structure where each item was related to the general factor and loaded strongly on a single group factor and only weakly on any other group factors.

Hence, the quantitative, data-driven item reduction was successful in producing a model with a much smaller number of items and an interpretable factor structure. However, the results from Stage 2 were not intended to represent the final measurement model of dance sophistication. In fact, the exclusion of many items due to high skewness or kurtosis and the lack of a factor reflecting observational dance experience limited the resulting model. To overcome these limitations, we used the reduced item set to serve as the basis for Stage 3, and added six items specifically targeting observational dance experience (through a continuum of expertise from formal to professional) to achieve a more balanced distribution of responses in relation to the construct of dance sophistication as produced in Stage 1.

Stage 3 - Construction, evaluation, and validation of a factor model of dance sophistication

The aim of Stage 3 was the construction, evaluation, and validation of a factor model of dance sophistication with a new sample of participants. The reduced set of items generated in Stage 2 served as the main item input, in addition to six new items to specifically assess different aspects of observational dance experience. For Stage 3 we intended to collect two separate samples for model estimation and model evaluation in order to avoid overfitting and thus obtain generalisable indicators of model fit.

Stage 3 – Method

Participants

Participants for both samples were recruited from among Goldsmiths undergraduate students who received course credits for their participation. After excluding participants who had completed less than 50% of the survey questions, or who had given constant ratings to all items, sample 1 comprised 127 participants (82.7% female) with a mean age of 20.8 years (SD = 5.21) and sample 2 had 190 participants (76.7% female) with a mean age of 19.6 years (SD = 2.83).

Materials

The 28 items of the reduced item set that resulted from the study in Stage 2 were used for the dance sophistication questionnaire. Additionally, six items which assessed different forms of observational dance experience were included. These were created by rewording some of the original items that had been excluded due to an imbalanced distribution of responses. Hence, in total the full set of dance sophistication questions for Stage 3 comprised of 34 items. The survey for sample 1 also contained seven questions on the demographic background of participants and two additional questionnaires to validate individual aspects of the Gold-DSI. The first of these was the Multidimensional Assessment of Interoceptive Awareness scale (MAIA; Mehling et al., 2012). This includes eight scales related to dimensions of body awareness: Noticing, Not-distracting, Not-worrying, Attention Regulation, Emotional Awareness, Self-regulation, Body listening and Trusting. Trusting relates to the belief that the sensations of the body provide safe and trustworthy feedback, which is helpful in terms of making decisions and having a sense of self. Attention regulation reflects the ability to "sustain and control attention to body sensations" (p. 16), whereas Self-regulation is related to "a strong ability to regulate distress by attention to the body" (p. 16). Not-distracting refers to the way in which individuals resist using distraction to cope with discomfort, and noticing assesses the awareness of a range of body sensations. We also included the Openness subscale from the Big Five Inventory (BFI; John, Naumann, & Soto, 2008).

Finally, the survey for sample 2 contained the Gold-MSI (Müllensiefen et al., 2014), for correlational comparison. In addition to a general scale of musical sophistication, the Gold-MSI includes subscales of Active Musical Engagement, Perceptual Abilities, Singing Abilities, Musical Training and Emotional Engagement with Music. The internal consistency for the MAIA scales ranged from .66 to .82, for the Openness to Experience scale, and for the

Gold-MSI scales, .79 to .93. Both surveys were implemented through the Qualtrics (Provo, Utah) online survey platform.

Procedure

Participants were directed to the survey's landing site during a lecture on practical issues in psychology. They gave consent for participating in the study after receiving a short explanation about the survey's purpose and content. All participants received a comprehensive debrief in class after completing the survey.

Stage 3 – Results

Sample 1 was used to construct the factorial model of dance sophistication and sample 2 was used for model evaluation using confirmatory factor analysis.

Model construction

The construction of the factor model followed the analytic procedure described in the study in Stage 2. Only one variable was excluded due to a skewness value > 2. All of the remaining 33 variables had skewness and kurtosis values < 2. Subsequently the hierarchical omega coefficient was computed and yielded a value of 0.64, which indicated the presence of a general factor. Therefore, a series of hierarchical factor models (minimum residual factoring with oblimin rotation) were computed where each model contained a general factor and between three and 10 secondary group factors (i.e., so-called Schmid-Leiman models).

Models were compared on the Bayesian Information Criterion and a model with four secondary group factors showed the best model fit. The difference in BIC values to next best model was 19.4 and therefore substantial. As a next step, 11 items with a low communality (h < 0.5) were removed and the model comparison step was run again. The model with four sub-factors showed again the best model fit according to the BIC (the difference to the second-best model was 20.4). In order to ensure a simple factorial structure, we excluded one further item where the ratio of the loading of the strongest group factor to the loading on the second

strongest group factor was < = 1.5. This resulted in a final set of 21 items in the model having one primary and four secondary factors. Finally, we removed one item which had a negative coefficient estimate on its group factor despite being worded positively. Thus, the final model comprised 20 items, each loading on one secondary group factor and the general factor of participatory dance experience. The secondary group factors were interpreted as 1. Body awareness (6 items), 2. Social dancing (6 items), 3. Urge to dance (5 items), 4. Dance training (3 items).

We have conceptualised dance sophistication as a combination of experience in *doing*, *watching* and *knowing about* dance (Orgs et al., 2018). The participatory factor of dance sophistication comprises a general factor and four sub-components of expertise in *doing* dance. However, none of the factors in the models measured any aspects of *watching* or *knowing about* dance. Therefore, we selected nine items from the initial set of Study 3 comprising 34 items that assessed behaviours related to observational dance experience and ran a separate factor modelling procedure on this set of variables to potentially identify a common factor. None of the nine variables was part of the final model of participatory dance experience. Similar to the analytical procedures described before we screened for variables with high skewness or kurtosis and excluded one variable. This was followed by a minimum residual factor analysis requesting only a single factor. From this model we excluded two items with a low communality of < 0.3, which yielded the final set of six items measuring observational dance experience. Running the factor analysis again showed that each of the items had a loading > 0.55 on the single factor (see Table 3) and a communality of > 0.31.

Table 3: Numerical Factor loadings for dance participation (P1 - P4) and dance observation (O1).

Item	Factor Loadings	General Factor Loadings
P1.1	0.57	0.61
P1.2	-0.57	-0.57
P1.3	0.52	0.55
P1.4	-0.72	-0.34
P1.5	0.62	0.49
P1.6	0.60	0.59
P2.1	0.14	0.83
P2.2	-0.15	-0.77
P2.3	0.51	0.73
P2.4	0.01	-0.79
P2.5	0.29	0.70
P2.6	-0.18	-0.85
P3.1	0.32	0.80
P3.2	-0.21	-0.66
P3.3	0.62	0.64
P3.4	0.51	0.60
P3.5	0.50	0.66
P4.1	0.76	0.45
P4.2	0.48	0.54
P4.3	0.79	0.44
O1.1	0.63	N/A
O1.2	-0.66	N/A
O1.3	0.63	N/A
O1.4	-0.60	N/A
O1.5	0.65	N/A
O1.6	0.56	N/A

Note: For the factor dance participation (P1 to P4) values are standardized loadings computed on the model construction sample 1 and derived from a confirmatory factor model with robust maximum likelihood estimation. Note that some items may have low loadings on their primary group factor but comparatively high loadings on the general DSI factor. For the factor dance observation (O1), values are standardized loadings computed on the model construction sample 1 and derived from an exploratory factor model computed with minimum residual factor analysis method. Note that the general factor only relates to dance participation and not

to dance observation, hence N/A (Non-Applicable) for all O1 Items in the general factor loadings column.

Model Evaluation

Model fit and internal consistency

Sample 2 was used for model evaluation. The factorial model of dance sophistication was evaluated using a minimum residual confirmatory factor analysis with robust maximum likelihood estimation. The four factors were specified to be orthogonal because the general factor already accounts for correlations between factors. All robust fit measures indicated an acceptable to good fit of the model to the data of sample 2 (*chi-square* = 242.3, *df* = 150, $p < 0.001$, *CFI* = 0.957, *TLI* = 0.946, *RMSEA* = 0.059 [90% *CI*: 0.045, .072], *SRMR* = 0.054). The single-factor model of observational dance experience was similarly evaluated by a *CFA* with robust maximum likelihood. The robust measures of model fit were in an acceptable range (*chi-square* = 24.1, *df* = 9, *p* = 0.004, *CFI* = 0.918, *TLI* = 0.863, *RMSEA* = 0.094 [90% *CI*: 0.052, 0.137], *SRMR* = 0.06).

Reliability of the individual subscales was in a good to very good range according to the common benchmarks given for Cronbach's alpha as shown in Table 4. The final list of items and scoring instructions are provided in Appendix C.

Table 4. *Internal Validity of the Goldsmiths Dance Sophistication Index*

Subscale	Number of items	Cronbach's alpha
General Factor (PG): Participatory Dance Experience	20	.93
Factor 1 (P1), Body Awareness	6	.90
Factor 2 (P2), Social Dancing	6	.91
Factor 3 (P3), Urge to Dance	5	.83
Factor 4 (P4), Dance Training	3	.82
Observational Dance Experience (O1)	6	.79

Correlational assessment of concurrent and divergent validity

Openness to Experience and Body Awareness

While no measure of dance sophistication in the academic literature exists as yet, the subscales of the DSI can be hypothesised to be related to several other constructs. These include body awareness and Openness to experience (sample 1) and musical sophistication (sample 2) as presented in the following section. Table 5 presents the correlations with DSI factors and the Openness to experience subscale from the BFI and the MAIA inventory.

Only one positive correlation between subscales of the Gold-DSI and the MAIA inventory was revealed, $r = .33$, $p = .04$. This was between the Gold-DSI subscale Body Awareness (Factor 1) and the MAIA subscale for Trusting. No significant correlations were found between dance participation (general or sub-factors) or dance observation with Openness to experience.

Table 5. *Sample1: Pearson Correlation Coeffi cients and p values between Dance Sophistication Index factors, BFI Openness to experience and MAIA.*

	P1: Body Awareness		P2: Social Dancing		P3: Urge to Dance		P4: Dance Training		PG: Participation		O1: Observation	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
BFI												
Openness to Experience	0.11	0.66	0.14	0.66	0.15	0.66	0.02	0.84	0.14	0.66	0.20	0.24
MAIA												
Noticing	0.19	1.00	0.09	1.00	0.08	1.00	0.17	1.00	0.16	1.00	0.08	1.00
Not Distracting	0.20	1.00	0.11	1.00	0.07	1.00	0.16	1.00	0.16	1.00	0.19	1.00
Not Worrying	0.12	1.00	0.06	1.00	-0.04	1.00	0.06	1.00	0.06	1.00	0.11	1.00
Attention Regulation	0.23	0.99	-0.02	1.00	-0.08	1.00	0.09	1.00	0.07	1.00	0.01	1.00
Emotional Awareness	0.14	1.00	0.16	1.00	0.27	0.33	0.11	1.00	0.21	1.00	0.24	0.88
Self-regulation	0.22	1.00	0.12	1.00	0.23	0.89	0.13	1.00	0.21	1.00	0.26	0.44
Body Listening	0.08	1.00	0.02	1.00	0.13	1.00	-0.02	1.00	0.07	1.00	0.18	1.00
Trusting	0.33	**0.04**	0.15	1.00	0.20	1.00	0.09	1.00	0.25	0.62	0.19	1.00

Goldsmiths Musical Sophistication Index (Gold-MSI)

Table 6. *Sample 2: Pearson Correlation Coefficients and p values for Dance and Music Sophistication Factors*

	F1: Body Awareness		F2: Social Dancing		F3: Urge to Dance		F4: Dance Training		FG: Participation		FP: Observation	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Gold MSI												
Active Engagement	0.21	**0.03**	0.35	**0.00**	0.40	**0.00**	0.35	**0.00**	0.39	**0.00**	0.28	**0.01**
Musical Training	0.24	**0.03**	0.22	**0.03**	0.27	**0.01**	0.38	**0.00**	0.32	**0.00**	0.15	0.08
Emotion	0.38	**0.00**	0.39	**0.00**	0.41	**0.00**	0.41	**0.00**	0.48	**0.00**	0.30	**0.00**
General Music Sophistication	0.39	**0.00**	0.35	**0.00**	0.46	**0.00**	0.39	**0.00**	0.47	**0.00**	0.34	**0.00**

Correlations between the Gold-DSI (general participatory dance experience and subscales, and observational dance experience) and the Gold-MSI (general and subscales) are shown in Table 6. Almost all subscales of the DSI correlate significantly (before correction for multiple comparison) and with small to medium effect sizes with the four subscales of the Gold-MSI. The highest correlations for the DSI subscale of Body Awareness (Factor 1) are General Musical Sophistication and Emotional Music Sophistication. The Gold-DSI subscales of Social Dancing (Factor 2) and Urge to Dance (Factor 3), and the Observational Dance Experience scale all correlate most highly with the General Musical Sophistication factor of the Gold-MSI and the subscales of Emotional Music Sophistication and Active Engagement with music. Finally, the general dance sophistication factor of Participatory Dance Experience and the subscale of Dance Training (Factor 4) of the Gold-DSI and have substantial correlations ($.31 < r < .49$) with all four subscales of the Gold-MSI.

Discussion

Dance has become an increasingly important topic in psychology and neuroscience research and provides a new route for developing movement-based interventions for health and wellbeing. In order to evaluate the effect of dance on physical, psychological and socio-

emotional wellbeing, it is important to assess individual differences in dance experience. The Gold-DSI as a self-report measure of dance sophistication distinguishes between participatory and observational components of dance experience and provides a continuous rather than categorical measure of a person's engagement with dance.

Dance participation vs. observation

Our findings support the notion of participatory and observational dance experience as distinct constructs of dance sophistication that share little common variance. Participatory dance experience captures the amount and type of dancing a person does, including dance classes or professional dance training, but also social dancing. These formal and informal components of participatory dance experience are captured in the subfactors dance training and social dancing, respectively. We identified two additional subcomponents of participatory dance experience: a person's motivation or urge to dance, and body awareness.

Dancing has been shown to improve proprioceptive (Jola, Davis, & Haggard, 2011) and interoceptive (Christensen, Gaigg, Calvo-Merino, 2018) perception. These effects of dance experience are captured as the body awareness subfactor in the Gold-DSI. Body awareness was validated with the MAIA survey. The only correlation between Gold-DSI and the MAIA inventory was between the Gold-DSI subscale of Body Awareness and the MAIA subscale for Trusting. Trusting relates to the belief that the sensations experienced within one's body provide safe and trustworthy feedback, which is thought to be helpful in terms of having a sense of self, and for making decisions about one's health (Mehling et al., 2012). This relationship then suggests that body awareness is linked to confidence in perceiving one's bodily signals. Future studies should validate whether this heightened confidence in perceiving interoceptive signals indeed translates to greater accuracy in detecting interoceptive signals (Christensen, Gaigg, Calvo-Merino, 2018). Individual differences in body awareness, might help to explain how dance training impacts on body image

(Robbeson, Kruger, & Wright, 2015) and differential strategies for coping with pain and injury among professional dancers (Alexias & Dimitropoulou, 2011).

Interestingly, some studies suggest that professional dancers are at a greater risk for body dissociation (Thompson & Jaque, 2013), suggesting a negative rather than positive relationship between dance expertise and body awareness. Observational dance experience was not associated with any of the subscales of the MAIA, suggesting that watching dance alone is not sufficient to permanently alter a spectator's experience of their own bodily signals; this seems to require either dance training or regular social dancing.

Comparing dance and music sophistication

The Gold-DSI subscales of social dancing, urge to dance, and the separate factor of observational engagement with dance were all associated with the Gold-MSI factors of emotional and active engagement with music, as well as with general music sophistication. From an evolutionary perspective, music making and dancing share a common origin in promoting and communicating social cohesion between groups (Grahn & MacAuley, 2009; Koelsch, 2014; Sevdalis, & Keller, 2011). In this way, both dance and music are intrinsically social activities. Interestingly, the social dancing factor of the DSI was not associated with any of the MAIA scales, nor with openness to experience, suggesting a *self*-related aspect of dance sophistication that encompasses participatory dance experience and body awareness as opposed to an *other*-related aspect of dance sophistication captured by the urge to dance and social dancing factors; both are captured by the Gold-DSI.

The relationship between music and the 'urge to move' has been of interest since studies showed that music can prime the motor areas of the brain for movement (Phillips-Silver, 2009; Zatorre, Chen & Penhune, 2007). Specifically, studies of *groove* in music have linked the pleasurable experience of listening to music with the urge to move (Janata, Tomic, & Haberman, 2012; Senn et al., 2019; Witek et al., 2014). For future studies, combining both

the Gold-DSI and Gold-MSI may thus help to explain individual differences in preferences for, and responses to, groovy music. Similarly, music and dance sophistication may be closely linked in individuals who perform well on rhythm and beat perception tasks (Dalla Bella et al., 2017; Grahn & Brett, 2007; Phillips-Silver et al., 2010; Sowiński & Dalla Bella, 2013).

Whilst both participatory and observational dance experience are positively associated with the general factor of the Gold-MSI and the subfactors of emotional music sophistication and participatory engagement with music, no significant relationship was found between observational dance experience and music training. This suggests a close relationship between dance and music sophistication overall, yet the appreciation of dance does not appear to depend on musical training.

Limitations

It is important to note that although our mixed methods approach ensured content validity, the data reported here for studies two and three are largely based on student samples. Further research will be necessary in order to provide normative data to assess differences in specialist populations, such as professional dancers, and also for the evaluation of dance-based interventions. Similarly, the social cultural value of dance varies substantially across cultures and so future studies should endeavour to find suitable translations of these concepts in order to explore cross-cultural similarities and differences.

By design the DSI should be applicable to any adult population recruited in Western countries. However, a dedicated study of the change in dance sophistication with age is still outstanding and would also be necessary to provide age-related norms for the subscales of the DSI. Nonetheless, the DSI can already be used as a tool in the context of aging and neurodegenerative disease interventions if used with a sample of participants within an older age bracket that is reasonably narrow. Here, one potential use of the DSI would be as a

recruitment tool to identify individuals with higher levels of dance sophistication who could be sufficiently motivated and able for an intervention to be successful.

Somewhat surprisingly, we did not observe any significant correlations between participatory or observational dance experience and openness to experience, which is interesting because this personality trait has been associated with aesthetic appreciation of movement-based arts (Luck, Saarikallio, & Toivianen, 2009; McCrae, 2007). We speculate that this may be due to the fact that items to assess observational dance experience were specifically designed to include watching dance on television, YouTube and other streaming platforms, rather than watching live dance performances alone. Presumably, watching dance on TV or on social media platforms favours popular culture dance styles such as street dance or ballroom over 'high-art' performing dance in the live theatre situation. Yet, in the context of dance, openness to experience is related to engagement with contemporary and postmodern approaches to dance and choreography, i.e. dance without music (Jola, Pollick, & Calvo-Merino, 2014). Importantly, the GOLD-DSI provides a new tool to explore these and other relationships between dance sophistication, personality traits and engagement with specific dance styles.

Conclusions

The Gold-DSI is the first standardised psychometric tool to assess individual differences in dance sophistication as a continuous and multifaceted variable. This will enable the systematic study of dance and choreography in rehabilitation programmes for a range of pathologies, as well as in psychological and cognitive neuroscience research. Importantly, participatory and observational dance experience did not show much common variance, in line with the idea that it is possible to be an avid fan of dance without dancing oneself. As such, we offer a definition of dance sophistication as concept encompassing both

participatory and observational dance experience including dance training, body awareness, the urge to move and the social aspects of dancing.

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