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The Warburg Dance Movements Library –the WADAMO Library. A validation study.

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Abstract

The Warburg Dance Movement Library (WADAMO Library) is a validated set of 234 video clips of dance movements for empirical research in the fields of cognitive science and neuroscience of action perception, affect perception and neuroaesthetics. The library contains two categories of video clips of dance movement sequences. Of each pair, one version of the movement sequence is emotionally expressive (clip a), while the other version of the same sequence (clip b) is not expressive but as technically correct as the expressive version (clip a). We sought to overcome a series of pitfalls of previous dance libraries. Facial information, colour and music have been removed and each clip has been faded in and out. We equalised stimulus length (6 seconds, 8 counts in dance theory), the dancers' clothing, video background and included both male and female dancers, and we controlled for technical correctness of movement execution. The WADAMO Library contains both contemporary and ballet movements. Two online surveys (N=160) confirmed the classification into the two categories of expressivity. Four additional online surveys (N=80) provided beauty and liking ratings for each clip. A correlation matrix illustrates all variables of this norming study (technical correctness, expressivity, beauty, liking, luminance, motion energy).

Keywords: Emotion; dance; authenticity; expression; action perception; movement; affect

The Warburg Dance Movements Library –the WADAMO Library. A validation study.

'Technical perfection is insufficient. It is an orphan without the true soul of the dancer.'

— Sylvie Guillem

1. Introduction

The Warburg Dance Movement Library (WADAMO Library) is a normalised set of 234 video clips of dance movements for empirical research in the fields of cognitive science and neuroscience of action perception, affect perception and neuroaesthetics. The library contains pairs of video clips of dance movement sequences. Of each pair, one version of the movement sequence is expressive (clip a), while the other version of the same sequence (clip b) is not expressive but as technically correct as the expressive version of the same dance sequence (clip a). This is the first set of dance movement clips for empirical research that has been created to provide two categories of expressive dance movements. In addition to the norming values for 'expressivity', several other relevant norming values are reported for each video clip. These include 'beauty' and 'liking' ratings, and objective measures of luminance and motion energy. In this introductory part of the paper, we will outline the background for this stimuli library, (i) reviewing the use of dance movement stimuli in scientific research ('*Dance in scientific research':* section 1.1.), (ii) artistic aspects of dance movements to be considered when creating dance stimuli materials in the empirical sciences ('*Formalist* versus *expressive dance as stimuli materials in the empirical sciences*'; section 1.2.), before finally, (iii) describing the design of the WADAMO Library, based on previous work (*'The WADAMO Library'*: section 1.3.).

1.1. Dance in scientific research

Since the seminal paper by Calvo-Merino, Glaser, Grèzes and Haggard (2005) on the neuroscience of dance, the past 13 years have seen a constant increase of studies researching

dance from a scientific point of view. This first study was published in the journal *Cerebral Cortex* and according to the *Web Of Science*, it has been cited more than 900 times since then. The art form dance has motivated several different lines of research in cognitive science and neuroscience, including action perception, affect perception, and dance as a source of aesthetic experience (for reviews, see Bläsing et al., 2012; Christensen & Calvo-Merino, 2013; Cross & Ticini, 2011; Cross, Acquah, & Ramsey, 2013). We will first provide a brief overview of this literature, where dance movement videos have been used as stimuli materials and show how stimuli used across these studies have varied considerably and suffered from several pitfalls. We then outline how the present stimuli library aims to overcome these.

Action perception. After the seminal discovery of mirror neurons in the monkey brain (MNs; di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996), much research focussed on describing the overlapping brain mechanisms for performing and observing actions also in the human brain (in premotor and parietal cortices; Decety et al., 1997; Grafton, Arbib, Fadiga, & Rizzolatti, 1996). Dancers as participants and dance movements as a type of action stimuli have featured strongly in this research endeavour (Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005; Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006; Cross, Hamilton, & Grafton, 2006; Orgs, Dombrowski, Heil, & Jansen-Osmann, 2008). For example, the shared neural mechanisms of action observation and action execution were demonstrated in an fMRI study with ballet and capoeira dancers who watched ballet and capoeira dance movement video clips in the scanner. Neural responses in MN motor simulation regions were larger when the dancers watched dance movements of 'their' dance style (i.e., ballet dancers watching ballet movements and capoeira dancers watching capoeira movements), compared with when they watched movements belonging to the other style.

Affect perception. Similarly, in the domain of affect perception research, the evidence indicates that understanding/perceiving emotions of others' emotional body language engages the same brain regions that are involved in experiencing the same emotions yourself (Bastiaansen et al., 2009; Keysers, Kaas, & Gazzola, 2010; Wicker et al., 2003). Dance is an instance of emotional body language *par excellence* and has therefore been employed frequently as stimulus in such studies. For example, in a study using long segments of choreographed dance, participants' emotion ratings were collected, and when rTMS was applied over the posterior parietal cortex, participants' emotion ratings increased, suggesting an important role for the parietal cortex in emotional experience (Grosbras, Tan, & Pollick, 2012). People with and without dance experience correctly identify the emotions contained in dance movements, irrespectively of the cultural origin of these movements (Camurri, Lagerlof, & Volpe, 2003; Hejmadi, Davidson, & Rozin, 2000; van Meel, Verburgh, & de Meijer, 1993; Christensen et al., 2014). For example, previous studies have demonstrated that people correctly identify the emotions anger, disgust, fear, humor, sadness, heroism, love, peace, wonder, and lajya (a particular type of 'shyness' emotion) in a dance movement (Hejmadi et al., 2000; Sawada, Suda, & Ishii, 2003; Dittrich, Troscianko, Lea, & Morgan, 1996; Brownlow, Dixon, Egbert, & Radcliffe, 1997; Camurri et al., 2003; de Meijer, 1989).

Aesthetic experience. Most research on the arts and the brain has focussed on the visual arts and music (Cela-Conde et al., 2004; Jacobsen, Schubotz, Höfel, & Cramon, 2006; Kawabata & Zeki, 2004; see Cela-Conde, Agnati, Huston, Mora, & Nadal, 2011; Chatterjee, 2010; Di Dio & Gallese, 2009; Nadal, Munar, Capó, Rosselló, & Cela-Conde, 2008, Blood & Zatorre, 2001; Salimpoor & Zatorre, 2013). However, also the discipline 'neuroaesthetics of dance' is gaining momentum. The aesthetic experience that observers derive from dance movements is modulated by physical properties of the movements such as the extremeness of the posture (very extended stretches, high jumps, rounded lines or edgy lines; Calvo-Merino,

Jola, Glaser, & Haggard, 2008; Calvo-Merino, Urgesi, Orgs, Aglioti, & Haggard, 2010; Cross, Kirsch, Ticini, & Schütz-Bosbach, 2011; Daprati, Iosa, & Haggard, 2009; Stevens, Vincs, & Schubert, 2009; Stevens, 2005; Stevens, Malloch, McKechnie, & Steven, 2003; Stevens, Schubert, et al., 2009; Stevens, Vincs, & Schubert, 2009; Vincs, Schubert, & Stevens, 2007). For example, Daprati and colleagues' (2009) compared observers' aesthetic judgments to different versions of the same dance position taken from the performances of the London Royal Ballet's Sleeping Beauty, recorded at different time points over a 40-year period. Observers preferred the most recent depictions – which were also the most extreme ones. Similarly, Aronoff and colleagues (2006) found that audiences ascribed positive emotional qualities to dancers that moved with many round movements (round arabesque moves and pirouettes), while they ascribed negative emotional qualities to dancers than moved with edgy and straight line paths. Thus, emotional engagement with a dance performance appears to change as a function of the movements.

Stimulus materials used in the above studies have varied considerably in terms of their artistic appeal and value (Christensen & Calvo-Merino, 2013), and reservations have been articulated against some types of movement material that has been used as 'dance' stimuli (Christensen & Jola, 2015, for a discussion see also Jola, Ehrenberg, & Reynolds, 2011). The level of experimental control inherent to experimental psychology and neuroscience research requires stimuli materials to be particularly well-controlled. This has led researchers to use stimuli materials that are technically correct movement patterns from different dance syllabi, which are, however, qualitatively very alienated from the what an artist would call 'dance'. The Encyclopaedia Britannica defines dance as *an art form that generally involves body movements, which are usually rhythmic and performed to music, used as a form of expression, social interaction, or presented in a spiritual or performance setting*. While technically correct, most stimuli materials used so far are entirely deprived of the qualities listed in the second part

of this definition. A dance movement is 'technically correct' when the movements are executed in accordance with the specifications of the dance syllabus of the style which the dance originates from. This includes, but is not limited to, the placement of head, trunk, legs, turnout of legs, pointing of feet, and of course if someone is stumbling, forgetting a move or not following the prescribed tempo of a sequence. However, dance scholars stress that technical correctness is not enough to make a movement a dance. Comparison across studies is therefore difficult and we may even ask whether some of the previously used materials constitute dance at all.

1.2. Formalist versus *expressive dance as stimuli materials in the empirical sciences*

The distinction that we make between dance movements that are genuinely expressive *versus* dance movements that are merely technically correct but not expressive, is inspired by art theory and art history, as well as by dance history and pedagogy. In these fields, scholars make a distinction between expressive and formalist art. Expressive art and dance is the result of an inner state, physical sensations, or the expressive intention of the artist and dancer. The aesthetics of that art work or dance is just a by-product and not the main concern of the artist and dancer. Conversely, formalist art and dance is essentially about the aesthetics of lines and shapes, and has little or no interest in emotional expression or narrative, other than to induce pleasure, liking and awe in spectators (Calvo-Merino, Jola, Glaser, & Haggard, 2008; Christensen, Pollick, Lambrechts, & Gomila, 2016; Cross, Hamilton, & Grafton, 2006; Daprati, Iosa, & Haggard, 2009).

Under the formalist perspective, dance becomes "*dance for dance's sake*" (Kisselgoff, 1983, p. 1). Analysing the neoclassical ballets of George Balanchine whose work is entirely build on formalism (i.e. the beauty of lines and shapes of the dancing body in space), David

Michael Levin contends: "*..., classical ballet is not essentially mimetic, not essentially representational; rather, these functions merely enclose what is of the essence: the immanent sensuous beauty and grace of the dancing body*" (Levin, 1976, p. 1). Most research in empirical and neuroaesthetics, but also in the field of affective neuroscience using dance movements, has focussed on the aesthetics of the movements, disregarding expressivity entirely. It is true that to a lay audience, the aesthetics of a dance movement is most likely the first aspect of a dance that catches their attention (Kisselgoff, 1983). Yet, research suggests that the embodied experience of the expressivity of dance movements (and not just their aesthetic shape in space) could be an important aspect of why we as spectators (also lay audiences!) like a dance movement and art in general (de Gelder, 2006; Freedberg & Gallese, 2007; Gallese, 2005, 2011; Herbec, Kauppi, Jola, Tohka, & Pollick, 2015; Jola & Grosbras, 2013; Jola, Pollick, & Grosbras, 2011; Latif, Gehmacher, Castelhano, & Munhall, 2014; Leonards et al., 2007).

The expressive power of dance (and not its formalistic-aesthetic aspects) has been echoed in various evolutionary, art-historian and anthropological texts about dance since the 19th century, including those of Charles Darwin (Darwin, 1871), Alfred Radcliffe-Brown (Radcliffe-Brown, 1922), Aby Warburg (Warburg & Mainland, 1939), and Edward Evans-Pritchard (Evans-Pritchard, 1928). Notably, also the oldest still preserved text about dance, the more than 2000-year old Indian text *Natya Shastra*, is concerned, not with aesthetics of dance, but with how to express different emotions, intentions and entire narratives with the body in a dance (Hejmadi, Davidson, & Rozin, 2000; Jola, Abedian-Amiri, Kuppuswamy, Pollick, & Grosbras, 2012; Ramaprasad, 2013). It is therefore not surprizing that the sole concern for aesthetics and beauty of dance movements, deprived of expressivity and meaning has outraged many dance scholars, pedagogues and choreographers, including Mary Wigman and Rudoph Laban, who believe that such dance is "empty" (Lunay, 1996).

Another concern with exclusively formalist dance practices is the elevated risk of injury. In the 1970s, a discipline called 'Somatics' emerged among dancers (Hanna, 1995). It specifically sets genuine expressivity centre stage in dance practices, and is said to have *"transformed* [dance] *pedagogy into a more 'active' and exloratory experience of the student, in which physical sensations are more important than the mirroring and reproduction of forms"* (Ginot, Barlow, & Franko, 2010, p. 12). Furthermore, dance scholar and pedagogue Janet Karin, OAM, points out that "*the process of transmitting ballet's complex technique to young dancers can interfere with the innate processes that give rise to efficient, expressive and harmonious movement*" (Karin, 2016, p 1). Importantly, the insights that we gain from the writings of the field of somatics and from Laban's or Karin's theories on efficient movement, add a crucial observation for the comparison between formalist and expressive dance practices: In their strive for "higher, longer, faster" movements, formalist dance practitioners often ignore physical and mental sensations related to their practice. This increases the risk of injury.

Importantly for a dance movement library, the stimuli should be created respecting the insights from the dance world. A lack of interdisciplinary communication about the expressivity "behind" a movement that appears merely aesthetic to a lay person, might also be the reason why some researchers have disregarded the expressive aspect of dance stimuli materials in their work. We therefore put forward a movement library which includes this specific contrast between expressive movements and movements that are not expressive. We specifically design this stimulus library to be used with lay audiences, while making sure that the dance movements are technically sound from a dance-artistic point of view. Therefore, professional dancers will be involved in the stimuli creation processes (e.g. in choreography, dancing and rating the technical correctness of the movements), while participants with no dance experience will be recruited for the norming experiments.

We also attempt to create this dance movement library with a comparable level of experimental control as in the International Affective Picture System (Lang & Bradley, & Cuthbert, 2008), the International Affective Digital Sounds (Bradley, & Lang, 1999), stimuli sets of video clips of emotional body language or facial expressions of emotion (e.g., Atkinson et al, 2004; O'Reilly et al., 2015), and of musical sounds (Featherstone, Waterman, Morrison, 2012).

A first attempt to provide such normalised library of dance video clip materials for empirical research in dance is Christensen et al. (2014a). This set has been used in research on affect perception (Christensen et al., 2014b, 2016b), and aesthetic perception (Christensen et al., 2016a). However, some pitfalls make this stimulus library difficult to use in a neuroscientific setting. The library contains video clips depicting variable stage backgrounds, costumes and variable kinds of movements in different stimuli categories. There are also no specifically neutral movement sequences and the dancers are all female. The objective of the WADAMO library is to provide a set of dance movements that overcomes these pitfalls, while also being informed by a dance art–historical perspective (Bullot & Reber, 2013).

1.3. The WADAMO Library

As in all emotional body language stimuli (e.g., Atkinson et al., 2004), we have removed all facial information from the stimuli. The human brain processes facial information effortlessly and automatically in designated neural systems that detect intention and emotion from a face (Kanwisher, McDermott, & Chun, 1997). Previous research with dance movements as stimuli has therefore relied on materials where the dancers' faces had been blurred (e.g., Calvo-Merino et al., 2005; de Gelder & Van den Stock, 2011). Furthermore, we recorded our clips without music. Although dance is thought to be invariably linked to music (Carroll & Moore, 2012), music is a separate art form that triggers its own aesthetic and affective processes

(Christensen et al., 2014b; Koelsch et al., 2010; Salimpoor, et al., 2015), and motor processes (Cheng, et al., 2008, Kornysheva et al., 2010) in the human brain. In affect and action perception studies, music could therefore be a confounding factor. Previous studies have mostly used dance without music (e.g., Calvo-Merino et al., 2005; Cross et al., 2011), although there are some exceptions that combined the two (e.g., Cross, Hamilton, Kraemer, Kelley, & Grafton, 2009; Christensen et al., 2014b). We chose six seconds as stimuli length based on the length of stimuli materials from previous studies. Most dance scholars would object to a dance choreography being 'cut' into such short sequences. However, the requirements of experimental control makes longer segments more difficult to handle. Two procedures helped us overcome this pitfall. We specifically *created* each movement sequence of six seconds for this stimuli library. This means that each sequence is a short choreography on its own. Furthermore, six seconds corresponds roughly to eight counts, which is the common length of a dance phrase in ballet and contemporary dance.

We focused on expressivity as our main variable of interest for the dance movements rather than creating dance movements of different emotional categories (sad, happy, angry, etc). Classically, it has been assumed that there are six basic emotions (sad, happy, angry, disgust, surprize, fear; Ekman & Friesen, 1971), while more recent accounts have identified up to 20 different expressions in everyday emotional body movement (Du, Tao, & Martinez, 2014), and Hejmadi et al. (2000) showed that up to eight emotional expressions in Indian Dance are recognizable by spectators, both by spectators of the same and from a different culture. Thus, there is some disagreement in the emotion literature about how many universal emotional expressions there are, and this is an empirical question in itself. Furthermore, another consideration was that the use of these emotion labels devised by experimental psychology in the 20th century is rather uncommon for dance scholars, and dancers rarely work according to these labels in their expressive work. In the present library, we therefore specifically sought to

provide the contrast between expressive and non-expressive movement, also because the previous dance movement library (Christensen et al., 2014a) already contained the contrast of positive-negative valence, but no "not-expressive" category. A future dance movement stimulus library might contain all components: non-expressive movements together with expressions of different emotions.

Previous work has found that physical properties of stimuli video materials (luminance and motion energy) may influence participants' subjective responses. Also, how beautiful participants find a stimulus, or how much they like them, may influence participants' engagement and experience with a task. Therefore, we collected beauty and liking ratings in additional norming experiments, and obtained luminance and motion energy values for each stimulus (see supplementary materials for the values). These data allowed us to explore whether the physical properties of the stimuli correlate with participants' subjective experience of the clips (ratings of expressivity, beauty, and liking), as suggested by previous literature (Cross, Kirsch, Ticini and Schütz-Bosbach, 2011). We believe that the WADAMO Library will be of interest for a series of empirical fields including experimental psychology, neuroscience, robotics, cognitive science and dance.

The next three parts describe the stages of the making of the WADAMO Library. Part 1 (section 2.) includes the '*Stimuli creation process'* which contains all information about how the video materials were obtained in collaboration with dance students from the *Rambert School of Ballet and Contemporary Dance* in London. It also includes all details regarding the editing process and how technical correctness ratings and physical properties (motion energy and luminance) for each clip were obtained. Part 2 (section 3.) explains the *'Stimuli validation experiments'*, where values of 'Expressivity' were obtained for each stimulus with a series of online surveys. Part 3 (section 4.) contains the *'Additional norming experiments'* in which values of 'Beauty' and 'Liking' were obtained in online surveys.

Finally, section 5. illustrates the *'Results of the six online surveys'* with figures and tables, and refers to the online supplementary materials that accompany this norming experiment, where all norming values and relevant descriptive data about the WADAMO Library can be found. Section 6. is a short *'Discussion and conclusion'* about the stimuli library and the results of the statistical analyses in the previous sections, relating them specifically to the formalist-expressivity considerations in the field of dance, outlined in the introduction.

2. Part 1: Stimuli creation process

In what follows, the stimulus creation is described.

2.1. Method – stimuli creation

All studies were approved by the local ethics committee of the School of Advanced Study of the University of London. The WADAMO Library was created in collaboration with dancers from the Rambert School of Ballet and Contemporary Dance in London.

2.1.1. Participants: The dancers

Two female and two male dancers (age: m = 18.25, SD = 0.5) from the Rambert School of Ballet and Contemporary Dance in London participated in this stimuli creation procedure. The dancers were 1st year students of the professional course of the school. They were selected by a draw among a group of available dancers and paid £20/hour for their time. The dancers were filmed one by one and wore tight fitting black clothes. The recordings were made against a white background in a dance studio generously provided by the Rambert School of Ballet and Contemporary Dance. Each dancer contributed with 2h of work to this project.

The contemporary dance recordings from one of the dancers had to be excluded due to technical error.

2.1.2. Instructions & Procedure

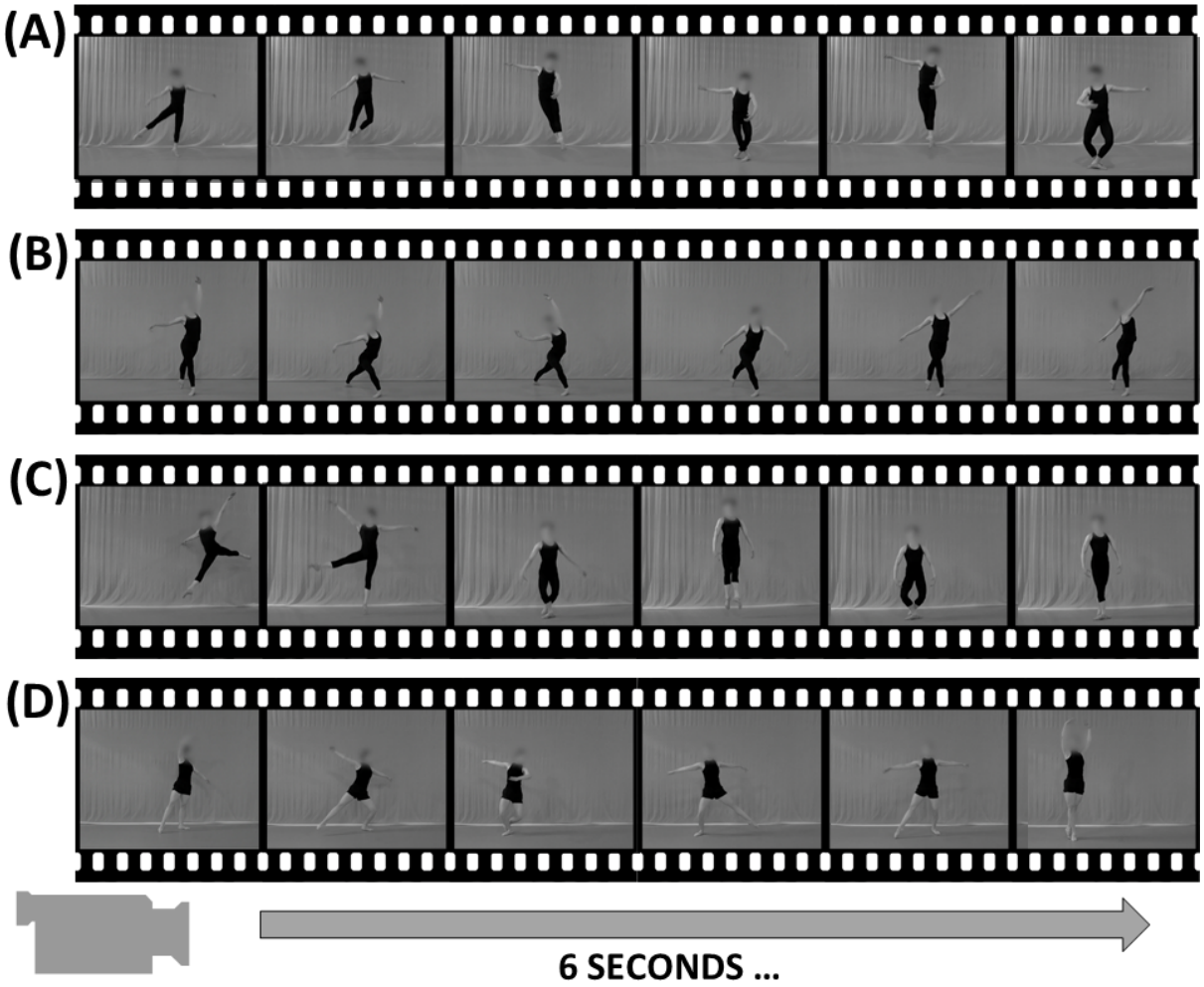
For the day of the recording, the dancers were asked in advance to bring dance sequences of the two styles, ballet and contemporary. The dance sequences could either be their own choreographies or from class exercises. It was emphasised to them that they should chose dance sequences which they enjoyed performing, because such material would be the easiest for them to portray both technically correct and with a genuine expressive intention. The dancers were informed before the day of the recording that the objective would be to portray each dance sequence both technically correct and deprived of any expressivity, as well as with expressivity, in several repetitions. The sequences were performed in the absence of music. The dancers were advised/guided through the portrayal of each sequence by JFC. JFC did not show any movements, nor did she give examples of expressions. All communications about expressivity, authenticity and technicalities of the sequences were communicated verbally in order to avoid any bias from the experimenter. The dance sequences therefore show the individual dancers' creative interpretation of the instructions. The instructions regarding expressivity of the movements followed Alexander and breathing technique (Fortin & Girard, 2005), and also autobiographical memory elicitation was used to make the dance movements authentic in expression (Shafir, Taylor, Atkinson, Langenecker, & Zubieta, 2013). For the not-expressive versions, it was emphasised that the dancers were to dance the movements technically correct but without any expressivity. 'Technically correct' in dance jargon refers to the mechanical execution of the movement itself. A dance movement is 'correct' if the dancer performs the movements as specified by the syllabi of the movement vocabulary of their style. For instance, the dancer is using the right turn-out of the legs, pointing/flexing of feet, respecting the right placement of hips, torso, head, and arms with respect to the movements of the legs, does not forget a step, does not lose balance, etc. Executing movements in a

'technically correct way' without any expressivity is a normal type of exercise in dance rehearsal contexts, where choreographies are normally first over-rehearsed motorically, and only when the movement execution is correct, the dancer will start to work on endowing their correct movements with expressivity. However, being asked specifically to deprive a movement of expression is somewhat unusual and required a few attempts to be successful for each dancer. It is important to note that expressive movements are not in any way more, or less, correct than versions of the movements that are "only" technically correct but without expressivity. These two attributes are independent of each other. The idea is that both versions of the movement sequence are equally correct, but one of the two is *also* expressive.

Filming was done throughout, to allow the recording of the largest possible quantity of attempts. The dancers first rehearsed each sequence, and when ready, indicated verbally which version of the sequence they were about to perform ('not-expressive', 'expressive-positive', or 'expressive-negative'). They always started by portraying the not-expressive version of the sequence. Then followed the expressive-positive or the expressive-negative version of the sequence, depending on the dancers preference and what they felt suited best for them in that moment (this procedure of self-choice was followed to allow the expressions to become as authentic as possible). If the dancer wished to repeat a sequence several times, this was granted as the selection of the best version would later be determined by the validation study.

The order of the 2-hour recording with each dancer was always 1) Ballet dance, 2) Contemporary dance. Ballet was recorded before Contemporary because this is the logical order for most dancers, who would find the opposite rather awkward. Due to the unconstrained nature of the instructions, promoting the authentic expression of the dancers, the final stimuli pool contained different numbers of each stimuli category from each dancer. See figure 1 for examples of the dance sequences of the four dancers.

Figure 1. Examples of dance sequences of the video clips filmed with the 4 dancers. The sequences contained dance movements of 8 counts, choreographed specifically for the WADAMO Library. Each video clip has a duration of ~6 seconds ± 0 -23 frames (one second has 23 frames).



2.1.3. Stimulus editing

The footage was edited with the MAC creative software Final Cut Pro 10.0. Due to the quantity of recorded footage, JFC made an initial screening of all footage and produced a shortened version of all usable footage for each dancer (JFC trained as a professional dancer). At this point all available stimuli materials were inspected and any stimuli that were technically incorrect (stumbling, out of balance, etc.) were discarded before any further editing. Then the

different versions of each dance sequence were edited to be exactly 6 seconds long ± 0 -23 frames. Special care was taken that the beginning and end points of each clip would be meaningful from a dance movement point of view (and not 'cut off' which would disturb at least expert viewers' experience of the clip, independently of the expressivity of the dancer's movement). The video clips were faded in and out (5 frames to fade in and 5 frames to fade out). The two first sequences of ballet movement clips of each dancer (i.e. 6 clips in total per dancer) were discarded before any further editing for two reasons, (i) because the stimuli creation procedure started with ballet dance and the dancers needed some time to adapt to the somewhat unusual situation of portraying movements that were 'not expressive', and (ii) both female dancers wore their hair in a loose pony tail at the beginning of the recording, distracting in the picture. They were therefore asked to put their hair into a knot instead. No clips with open pony tail remain.

Then, using the mask blur function of Final Cut Pro, the dancers' faces were blurred, frame by frame in each clip, all audio was removed, and a black and white filter was applied. All video clips of the WADAMO Library, the practice and catch trials are available free for download on YouTube, on the YouTube channel of the BIAS project of the Warburg Institute London: https://goo.gl/N8p78Q. An excel sheet with all values from the following stimuli validation study is available as supplementary materials of this article (see section 5. further down for a detailed description of the contents of the supplementary materials). See table 1 for an overview of the stimuli materials that conform the WADAMO Library.

Table 1

Available stimuli materials from each dancer in the stimulus pool

WADAMO LIBRARY –STIMULI POOL N = 234		
Dance Style	**CONTEMPORARY DANCE (N = 111)**	**BALLET DANCE (N = 123)**

Category	Not expressive	Expressive - positive	Expressive - negative		Not expressive	Expressive - positive	Expressive - negative		**Total both styles**
Dancer				***Total***				***Total***	
N Max:	15	16	19	***50***	11	8	14	***33***	**116**
N Clare:	10	11	10	***31***	10	10	10	***30***	**91**
N Mairi:	10	10	10	***30***	10	10	10	***30***	**90**
N Magnus:	0	0	0	***0***	10	10	10	***30***	**60**
N total:	35	37	39	***111***	41	38	44	***123***	**234**

2.1.4. Technical Correctness ratings

For the reader that is not expert in dance practice, please note that performing a dance movement without emotional expressivity does not reduce the quality of the movement in any way, nor does it imply that the movement is in principle less effortful. It simply is performed without any emotional intention. To ensure that no differences existed between Expressive movements and movements that were Not Expressive in terms of technical correctness, two professional dancers and one of the authors (JFC) rated the clips in terms of the technical correctness (total years of dance experience (combining all practiced dance styles): m = 25.67; SD = 6.03; years of ballet experience: m = 28.5; SD = 4.95; years of contemporary dance experience: m = 16; SD = 1.41). The two external raters were entirely blind to the objectives of the study, did not know about the expressivity variable, and did not know any of the dancers in the stimuli set.

By means of an online survey, programmed in the online software tool Qualtrics®, the dance professionals provided their ratings for each of the 234 clips, presented in randomised order, on a slider from 0 (incorrect) to 100 (correct). In the instruction of the task, the raters were informed that *"The clips were created with dance students so their movements are generally very good and correct. However, we'd like you to check for turn-out, stretching of feet, arm movements, placements and of course if someone is stumbling. Please disregard any aspects related to the artistic expressivity, beauty or how much you like the movements. This task is entirely about the technical correctness of the movements."*

Paired T-tests showed that there was no difference between the technical correctness (average between raters) for Contemporary dance videos (Not Expressive: m = 89.39; SD = 6.10; Expressive: m = 90.64; SD = 5.17; p = .171) and for Ballet dance videos (Not Expressive: m = 77.76; SD = 13.41; Expressive: m = 79.14; SD = 12.17; p = .449). This confirms that the clips of the two categories are equivalent in terms of technical correctness.

Interrater agreement scores were relatively low (Cronbach's alpha contemporary dance technical ratings: 17,2% and Cronbach's alpha ballet dance technical ratings: 45.45%). We attribute this to the fact that different dancers can have a different threshold to judge whether a movement is technically correct or not (e.g. if they have been trained in somatics teachings they might even reject the concept of "correct" and "incorrect" altogether; Fortin, Long, & Lord, 2002; Ginot et al., 2010). In Christensen et al. (2014) very high interrater agreement scores were found between the 3 judges. However, in the case of this other library, the movements were taken out of specified ballet choreographies for which a higher agreement exists regarding the succession of steps and their "correct" execution.

Irrespectively of their school, we can assume that the raters of the WADAMO Library have rated the clips consistently and that –whichever criterion they have applied– they will have used it for both expressive and non-expressive movements equally, since no significant differences between expressive and non-expressive clips were found in terms of technical correctness.

2.1.5. Physical properties of the stimuli

Luminance and motion energy information was obtained using a customized matlab script which 1) averaged the luminance score of each frame and 2) computed the number of pixels that changed in luminance from frame n to frame n + 1. The frame information was

summed up over the video frames to obtain the final measures. Values for each clip are available in the online supplementary materials of this article.

For the Contemporary dance videos, two One-Way ANOVAs were conducted with the factor 'Expressivity' as between-group variable, and luminance and motion energy as dependent variables, respectively. There was no difference between Contemporary videos that were not expressive and Contemporary videos that were expressive in terms of luminance ($F(1,110) = 1.213$, $p = .273$), nor of motion energy ($F(1,110) = 0.46$, $p = .831$).

For the Ballet dance videos, two One-Way ANOVAs were conducted with the factor 'Expressivity' as between-group variable, and luminance and motion energy as dependent variables, respectively. There was no difference between Ballet videos that were not expressive and Ballet videos that were expressive in terms of luminance ($F(1,122) = 0.065$, $p = .800$), nor of motion energy ($F(1,110) = 0.099$, $p = .754$).

2.2. Results & discussion: The stimulus set

The WADAMO Library contains N = 234 visual stimuli of dance movement sequences (video clips, duration: ~6 seconds, ±0 -23 frames). Of these N = 234 video clip stimuli, N = 111 stimuli contain contemporary dance sequences, and N = 123 stimuli contain ballet dance sequences. Within the list of stimuli of each dance style (N = 111 and N = 123), there are two categories of stimuli, expressive and not expressive versions of the same dance movement sequences. 'Expressive' and 'not expressive' means that the dancers executed the movements either with the intention to be emotionally expressive (i.e. 'expressive' videos), or without any expressive intention ('not expressive'). The dance movement sequences in the two categories (expressive and not expressive) are equally technically correct, possess the same physical properties in terms of luminance and motion energy, and vary only in expressivity. The dance movement sequences were choreographed specifically for this stimuli library and contain

sequences of 8 counts that last approximately 6 seconds. Professional dance students from the Rambert School of Ballet and Contemporary Dance, London, portrayed these dance movement sequences for the creation of the present stimuli library. Because some movement sequences might lend themselves best to be portrayed either in an expressive-positive, or conversely, in expressive-negative way, each movement sequence was danced and filmed at least 3 times by the dance students, with three expressive qualities: not expressive, expressive-positive, and expressive-negative. As mentioned earlier, if the dancers wished to repeat the recording of one version of a particular sequence, this was granted and all versions were kept (provided they were all technically equivalently correct). All versions of a sequence were later submitted to the validation study (see below), in order to determine which stimuli pair (not-expressive – expressive) yielded the most extreme ratings in the validation study (either not-expressive with expressive-positive, or not-expressive with expressive-negative). See table 2 for stimulus counts in each category.

Table 2

Description of the WADAMO Library: Number of clips in each category

WADAMO LIBRARY –STIMULI POOL N = 234						
Dance Style	**CONTEMPORARY DANCE (N = 111)**			**BALLET DANCE (N = 123)**		
Category	Not expressive	Expressive - positive	Expressive - negative	Not expressive	Expressive - positive	Expressive - negative
N	35	37	39	41	38	44

Regarding the difference between contemporary and ballet dance movements, in general contemporary and ballet dance movements are clearly differentiable. All possible ballet movements are prescribed by a strict movement syllabus that specifies the placement of head, neck, torso, arms, hips, legs and feet at each moment of a movement, be it a static, travelling

or jumping movement. Any deviation from these prescribed placements would be picked up by a dance expert as 'non-ballet' moves, as 'modifications' of a ballet move, or as an 'incorrect movement'. Thus, ballet movements are very distinctive, easily recognizable. By contrast, contemporary dance movements allow more freedom in the placement of the limbs in space. However, also within the different techniques of contemporary dance there are clear rules about the placement of the limbs in relation to each other and deviations are easily picked up by experts. For a dance expert, ballet and contemporary dance movements are very distinctive and easy to differentiate. Whether lay audiences would be able to differentiate the movements of the two dance styles is an empirical question, different from the one addressed in the present work. However, there is indirect evidence to suggest that audiences in general differentiate between the two styles, and possibly have a preference for one of the two. The statistics of ticket sales published by the *UK Theatre venue ticket sales benchmarking analysis* (2015) shows a difference in ticket sales between the two styles. For example, in 2013 there were 1062 ballet performances, 64% of the ticket capacities was sold and the average ticket price was 24,66 pounds, compared to 130 contemporary dance performances, with a 59% of ticket capacities sold and an average ticket price of 13,71 pounds in the same year.

3. Part 2: Stimuli validation experiments

To demonstrate the validity of the WADAMO Library, we investigated whether each stimulus would be recognized by non-expert viewers as intended by the dancer, either as expressive or as not expressive. By means of two online surveys (surveys 1 and 2), all clips were rated by independent raters on the question 'how expressive does the movement look to you?' on a slider scale from 0 (not at all) to 100 (very much). See validation experiment below.

3.1. Method – online validation surveys

All studies were approved by the local ethics committee of the School of Advanced Study of the University of London.

3.1.1. Participants – online surveys for expressivity ratings

One-hundred-and-sixty participants took part in the two online surveys, eighty in survey 1 (Contemporary dance clips validation study; mean age = 26.29, SD = 5.02, range 18-34) and eighty in survey 2 (Ballet dance clips validation study; mean age = 26.51. SD = 4.65, range = 18-34). The studies were advertised on Prolific®. On this platform participants need to be signed up and have provided extensive personal information to be able to participate. In this way it is ensured that no participants can participate twice in a study or without matching the inclusion criteria. Inclusion criteria was age (18-35 years) to match the dancers' age roughly, and country of residence (any European country) to match the cultural background of the two dance styles. Studies were set up so that no participant could participate in both Survey 1 and Survey 2. The samples of the two surveys are independent. Participants were compensated for their time (£6). See table 3 for further participant characteristics.

Table 3
Participant characteristics of online survey 1 and 2

	Online Survey 1 (Contemporary dance clips)		**Online Survey 2 (Ballet dance clips)**	
		Frequency (%)		***Frequency (%)***
Gender	Female:	41 *(48.8%)*	Female:	41 *(51.2%)*
	Male:	39 *(51.2%)*	Male:	38 *(47.5%)*
Professional dancer?	Yes:	2 *(2.50%)*	Yes:	2 *(2.50%)*
	No:	78 *(97.5%)*	No:	78 *(97.5%)*
Hobby dancer?	Yes:	16 *(20.0%)*	Yes:	14 *(17.5%)*
	No:	64 *(80.0%)*	No:	66 *(82.5%)*
Dance styles?	Social dances	16 *(20.0%)*	Social dances	18 *(22.5%)*
	Latin dances:	7 *(8.80%)*	Latin dances:	10 *(12.5%)*
	Contemporary:	4 *(5.00%)*	Contemporary:	4 *(5.00%)*
	Ballet:	3 *(3.80%)*	Ballet:	1 *(1.30%)*
	Folkloric:	1 *(1.30%)*	Folkloric:	2 *(2.50%)*
	Tap dance:	3 *(3.80%)*	Tap dance:	1 *(1.30%)*
	African dance:	2 *(2.50%)*	African dance:	1 *(1.30%)*
	Other:	13 *(16.3%)*	Other:	4 *(5.00%)*

	I don't dance:	50 *(62.5%)*	I don't dance:	60 *(75.0%)*
Ethnicity?	Caucasian:	49 *(61.3%)*	Caucasian:	67 *(83.8%)*
	Latin/Spanish:	2 *(2.50%)*	Latin/Spanish:	4 *(5.00%)*
	Asian:	6 *(7.50%)*	Asian:	4 *(5.00%)*
	Other:	9 *(11.3%)*	Other:	5 *(6.30%)*
	Prefer not to say:	1 *(1.30%)*	Prefer not to say:	0
	Missing:	18 *(22.5%)*	Missing:	0
First language?	English:	40 *(50.0%)*	English:	68 *(85.0%)*
	French:	3 *(3.80%)*	French:	0
	Spanish:	6 *(7.50%)*	Spanish:	6 *(7.50%)*
	Italian:	4 *(5.00%)*	Italian:	5 *(6.30%)*
	Other:	9 *(11.3%)*	Other:	1 *(1.30%)*
	Missing:	18 *(22.5%)*	Missing:	0

3.1.2. Procedure

Due to the large number of video clips (N = 234), two online surveys were conducted for the validation of the stimuli materials, separately for the contemporary dance clips (N = 111) and for the ballet dance clips (N = 123). The surveys were programmed using Qualtrics® and launched to a European sample of participants through the open source study distribution service Prolific®. All videos for the two surveys were uploaded to the BIAS project's private YouTube channel[1] and stimuli were displayed in Qualtrics® using the YouTube embed codes. To make sure that each video would be displayed without the usual YouTube handles (video title, video controllers, YouTube branding and suggested other choices at the end of the video), these handles were disabled using specific commands inserted into the syntax of the embed codes (the commands are: ?autoplay=1&&controls=0&disablekb=0&modestbranding=1&rel=0). The YouTube embed codes with and without these commands are available in the supplementary materials, should researchers wish to use them. Frame width and height were set to 1260 x 718 in the same syntax. In order to allow a smooth transition from the fade-out of each video clip to the question, a 4 second black screen buffer was added to the end of each video. Otherwise the

[1] https://www.youtube.com/channel/UCTAVChpnnjhH019EOCWIrbg/videos?sort=dd&view=0&shelf_id=0

YouTube transition to Qualtrics® would have been slightly abrupt. Each survey took about 45 minutes to complete and different participants took part in the two surveys.

Recognition rates for each stimulus were investigated by means of a rating task. In each survey, the dance clips (either contemporary dance or ballet dance clips) were displayed one by one and lasted 6 seconds each. After each clip, a 4 second black screen followed as a 'deliberation phase' where participants were invited to think about what response they might give. On the subsequent screen and after each video they rated each clip in terms of '*How expressive did the movement of the dancer look to you?'* Answers were given on a slider scale from 0 (not at all) to 100 (very much). After rating all stimuli, participants filled in their age, years of dance experience, whether or not they were professional or hobby dancers, and which dance styles they dance. Participants were also invited to indicate their ethnicity, first language and one final question in the survey asked how much they liked the dance video clips.

As this validation study was based on online survey data, three features were included in the paradigm to allow sanity checks of the data during data analysis. Prior studies suggest that people engage better in a cognitive task when they like what they are seeing. Therefore, the question '*How much did you like the dance movements in the video clips?*' was included as a final question at the very end of the Online surveys 1 and 2. Participants answered the question with a slider from 0 (not at all) to 100 (very much). Due to a technical error 18 participants of survey 1 were not given the chance to answer this question. All other participants answered the question. Second, research suggests that participant fatigue is a significant factor in performance in cognitive tasks. To explore the impact of this variable on ratings of the WADAMO Library, online survey 2 (Ballet dance validation study) contained the question '*how bored or sleepy were you during the task?*'. Participants answered the question with a slider from 0 (not at all) to 100 (very much). This question was asked at the end of the video rating block. Before participants answered the question, it was assured to them

that their answer to this question would not affect their payment in any way. In addition, because our surveys were online, we wanted to make sure that the videos had played adequately. After the rating task, participants were therefore asked *'did the videos play alright?'* 1 = not at all; 2 = Not very well; 3 = regular; 4 = Good; 5 = very good. Any participants that rated ≤ 3 were discarded and new participants recruited until filling the missing cases. Finally, both online surveys contained 2 catch trials (Charlie Chaplin doing funny and expressive moves). These were included to so we could measure in some way whether people had understood the task and were paying attention. We stipulated that inconsistent performance on the catch trials would mean that participants had not understood the instructions or were not paying attention. Three participants in Survey 1 (contemporary dance) and 4 participants in survey 2 (ballet dance) were excluded based on their catch trial performance. Their mean ratings on these catch trials were greater than 1.5 SD below the group mean, suggesting they rated the Charlie Chaplin videos as 'not expressive", See table 4.

Table 4

Catch trials summary

	Contemporary dance survey	**Ballet dance survey**
Catch trials – Charlie Chaplin	M = 75.66 SD = 23.597 Range = 6 – 100	M = 81.92 SD = 21.518 Range = 0 - 100

Due to a technical error in Qualtrics®, the first 18 participants only saw 110 stimuli of the 111 contemporary dance stimuli. For the remaining participants, all stimuli were presented.

3.1.3. Data analyses

For the recognition data, separately for each of the two surveys (Contemporary and Ballet), first, we submitted the ratings to a RM ANOVA with one factor with 3 levels

('Expressivity': not-expressive, expressive-positive, expressive-negative). We removed all participants that had rated the catch trials 1.5. SD below the mean of their respective groups (Contemporary vs Ballet) because such ratings indicated that the participants had either not understood the instructions or were not paying attention. Second, we obtained the percentage of correct responses for each stimulus category for each participant. Since we were using a continuous rating slider (0-100) for the recognition ratings, we transformed these data into 'number of correct responses' by coding all expressive stimuli that had been rated >50 and all 'not expressive' stimuli that had been rated <50, as '1'. All other ratings were given a '0'. Any ratings of exactly '50' were discarded (survey 1: 121 of 9023 data points (=1.34%) and survey 2: 129 data points of 10000 data points (=1.29%)). To obtain the percentage (%) of correct responses, the sum of correct responses was divided by the number of stimuli (110, 111, or 123) and multiplied by 100. The dependent variable 'Percentage of correct responses' (i.e. a type of 'acuity' or 'recognition score') was submitted to a RM ANOVA with one factor with 3 levels ('Expressivity'; not-expressive, expressive-positive, expressive-negative). For all ANOVAs: We did not expect any differences between the expressive-positive and the expressive-negative ratings. However, as the stimuli had been created using these instructions, all three levels were included in the ANOVAs. Third, Cronbach's alpha was obtained as an interrater reliability measure of internal consistency across ratings for each of the stimulus categories ('not-expressive', 'expressive-positive', 'expressive-negative' and 'not-expressive', 'expressive').

For each dance style two tables are available in the supplementary material that accompanies this paper. One table shows the video clips sorted as a function of the extremeness of the expressivity ratings; from very expressive (tending towards the rating of '100') to not expressive (tending towards the rating of '0'), irrespective of the prior classification of the clips into 'a' (expressive) and 'b' (not expressive) versions of the same sequence during the stimulus

creation. Furthermore, we provide a second table with an additional feature: where the 'a' and 'b' pairings of the sequences are respected. Using the expressiveness ratings, we matched the clips in terms of the most extreme versions of a set, 'a-b' ('expressive-positive' *or* 'expressive-negative, ('a'), with not-expressive, ('b')). This procedure resulted in 34 Contemporary dance stimulus pairs of 'a-b' sequences (N=68), and 41 Ballet dance stimulus pairs of 'a-b' sequences (N = 82). Paired t-tests for each category showed significant differences in the expressivity ratings for these 'a-b' pairs (all $p < .001$).

3.2. Results – validation experiments

3.2.1. Contemporary dance survey – Results (expressivity ratings)

A RM ANOVA with one factor with 3 levels ('Expressivity'; not-expressive, expressive-positive, expressive-negative) was computed to confirm that expressivity ratings matched the intended expressivity of the dancer in each stimulus clip. The analysis confirmed the intended classification into 'not-expressive' and 'expressive' movement sequences. There was a main effect of 'Expressivity' ($F(1, 75) = 52.596$, $p < .001$, $\eta^2 = .409$). Follow up paired t-tests confirmed a significant difference between 'not-expressive' and 'expressive-positive' clips ($t = -7.988$, $df = 76$, $p < .001$, Cohen's $d = .67$) and between 'not-expressive' and 'expressive-negative' clips ($t = -8.155$, $df = 76$, $p < .001$, Cohen's $d = .65$), while there was no such difference between 'expressive-positive' and 'expressive-negative' clips ($t = .319$, $df = 76$, $p = .750$, *ns*).

A second RM ANOVA was computed on the dependent variable 'percentage of correct responses' with one factor with 3 levels ('Expressivity'; not-expressive, expressive-positive, expressive-negative). The analysis was carried out to investigate whether the different categories of clips (expressive vs not expressive) had an equal percentage of correct responses. The results confirmed the intended classification into 'not-expressive' and 'expressive'

movement sequences. There was a main effect of 'Expressivity' ($F(1, 75) = 3.135$, $p = .046$, $\eta^2 = .040$), suggesting that there was a difference in percentage of correct responses, depending on the stimulus category (not-expressive, expressive-positive, expressive-negative). Follow up paired t-tests showed a significant difference between 'not-expressive' and 'expressive-positive' clips ($t = -2.014$, $df = 76$, $p = .048$, Cohen's $d = .43$), but no difference between 'not-expressive' and 'expressive-negative' clips ($t = -1.507$, $df = 76$, $p = .136$, *ns*), while there was no difference between 'expressive-positive' and 'expressive-negative' clips ($t = 1.642$, $df = 76$, $p = .105$, *ns*). This suggests that participants identified the expressive categories roughly equally well, though participants were better at identifying positive-expressive clips. See table 5.

Table 5

Results from RM ANOVA percentage of correct responses from the Contemporary Dance Survey (survey 1)

A: RM ANOVA – Main effects – *Contemporary dance survey (Percentage of correct responses)*

Expressivity	*Mean*	*SE*	*F-test (1,79)*	*p*	η^2
Not-expressive	50.46	2.01			
Expressive-positive	57.99	1.96	3.135	.048	*.040*
Expressive-negative	56.16	1.98			

Finally, correlations were performed between the expressivity rating data, the percentage of correct responses and the years of dance experience. Because there was no difference between expressive-positive and expressive-negative ratings, these were aggregated for this analysis to be one 'average expressive' rating score. Likewise, the percentage of correct responses were aggregated to be one single value of average percentage of correct responses across categories.

Years of dance experience (YDE) correlated positively with how expressive the participants thought the videos were ($p = .022$, $r = .260$), how many % correct responses they had ($p = .009$, $r = .295$), and with how much they liked the videos in general (Likert ratings) ($p = .006$, $r = .354$). These correlations suggest that especially 'dance experience' and how much people liked the videos influence expressivity ratings.

3.2.2. Ballet dance survey – ANOVA (expressivity ratings)

A RM ANOVA with one factor with 3 levels ('Expressivity'; not-expressive, expressive-positive, expressive-negative) was computed to confirm that recognition rates matched the intended expressivity of the dancer in each stimulus clip. The analysis confirmed the intended classification into 'not-expressive' and 'expressive' movement sequences. There was a main effect of 'Expressivity' ($F(1, 75) = 42.440$, $p < .001$, $\eta^2 = .361$). Follow up paired t-tests confirmed a significant difference between 'not-expressive' and 'expressive-positive' clips ($t = -8.072$, $df = 75$, $p < .001$, Cohen's $d = .54$) and between 'not-expressive' and 'expressive-negative' clips ($t = -6.391$, $df = 75$, $p < .001$, Cohen's $d = .31$), and also between 'expressive-positive' and 'expressive-negative' clips ($t = 3.859$, $df = 75$, $p < .001$, Cohen's $d = .17$), the expressive-positive videos being rated as more expressive than both the expressive-negative and the not-expressive movement clips.

A second RM ANOVA was computed on the dependent variable 'percentage of correct responses' with one factor with 3 levels ('Expressivity'; not-expressive, expressive-positive, expressive-negative). The analysis confirmed the intended classification into 'not-expressive' and 'expressive' movement sequences. There was a main effect of 'Expressivity' ($F(1, 75) = 10.604$, $p < .001$, $\eta^2 = .124$), suggesting that there is a difference in percentage of correct responses, depending on the stimulus category (not-expressive, expressive-positive, expressive-negative). Follow up paired t-tests showed a difference between 'not-expressive'

and 'expressive-positive' clips (t = -3.662, df = 75, p < .001, Cohen's d= .80), between 'not-expressive' and 'expressive-negative' clips (t = -2.925, df = 75, p = .005, Cohen's d = .65), and between 'expressive-positive' and 'expressive-negative' clips (t = 2.068, df = 75, p = .042, Cohen's d = .15). This suggests that participants rated all stimuli categories roughly equally well, but participants were more accurate when rating expressive-positive clips in general. See table 6.

Table 6

Results from RM ANOVA of expressivity ratings from the Ballet dance survey (Survey 2)

A: RM ANOVA – Main effects – *Ballet dance survey (Percentage of correct responses)*

Expressivity	*Mean*	*SE*	*F-test (1,79)*	*p*	η^2
Not-expressive	46.220	1.812			
Expressive-positive	58.487	1.661	11.255	< .001	*.125*
Expressive-negative	56.506	1.666			

Finally, correlations were performed between the expressivity rating data, the percentage of correct responses and the years of dance experience. Because there was no difference between expressive-positive and expressive-negative ratings, these were aggregated for this analysis to be one 'average expressive' rating score. Likewise, the percentage of correct responses were aggregated to be one single value of average percentage of correct responses across categories.

Years of dance experience (YDE) in this group did not correlate with how expressive the participants thought the videos were (p = .077, r = .204), but YDE did correlate positively with how many % correct responses participants had (p = .028, r = .252). YDE did not correlate with how much participants liked the videos in general (Likert ratings) (p = .131, r = .175), but YDE correlated negatively with how bored participants were with the task (p = .26, r = -256), the more dance experience participants had, less bored they were by the task. These correlations

suggest that 'dance experience' might have some relationship to how participants will engage with a task containing these videos.

3.3. Summary – validation experiment

The online surveys confirmed that participants with no dance experience were sensitive to the expressivity variable. They rated dance movements that were intended to be expressive as more expressive than dance movements that were not intended to be expressive. As previously noted, the videos of the expressive and not-expressive categories do not differ in terms of objective physical properties such as motion energy or luminance (all $p > .200$), nor in terms of technical correctness (all $p > .170$). An additional analysis in the percentage of correct responses in the two categories (expressive and not expressive) showed no difference between categories suggesting that participants found it equally easy to identify expressive and not expressive versions of the same movements. Participants' years of dance experience correlated with their ratings to the clips, with their percentage of correct responses and with how much they liked the videos. Participants with dance experience also found the task less boring.

Finally, regarding the sanity checks of the data, the survey behaviour of the participants suggests that how much participants liked the clips had an effect on their performance while how bored they were of the task did not seem to alter their pattern of responses. This suggests that including liking as a covariate might be a helpful variable to control of individual preferences while participant fatigue is not. Data about each stimulus is available in the supplementary materials that accompany this article, as 'Validation Data'. See table 7 for an overview of the descriptive data.

Table 7

Overview of the descriptive data and results of the recognition ratings, as well as the agreement scores.

	CONTEMPORARY						BALLET					
	N	*Mean*	*SD*	*Min*	*Max*	*Cronbach's alpha: % Agreement*	*N*	*Mean*	*SD*	*Min*	*Max*	*Cronbach's alpha: % Agreement*
Not expressive	35	47.43	10.24	19.80	81.11	84.7%	41	45.95	8.80	33.22	79.17	84.5%
Expressive - *positive*	37	54.12	9.61	27.08	79.65	82.8%	38	54.11	8.28	39.71	78.63	81.2%
Expressive - *negative*	39	53.94	9.71	29.62	82.54	84.7%	44	53.03	8.03	37.89	80.32	83.2%
All expressive	76	54.03	9.33	30.30	81.13	91.8%	82	53.94	7.85	38.73	79.54	90.4%

4. Part 3: Additional norming experiments (beauty & liking judgments)

In the field of neuroaesthetics, the subjective experience of participants is often measured by means of rating experiments where participants are asked to make judgments of beauty or in terms of how much they like each stimulus. Generally, beauty and liking are seen as different qualities of a stimulus (i.e. you need not find something VERY beautiful to like it, and you might find something VERY beautiful, but not really like it). Yet, in neuroaesthetics research they are seen as related since they are often correlated (see e.g. Christensen et al., 2014a). Outside the realm of neuroaesthetics, how much we like something or how beautiful we find something, influences our motivation to engage with it – also our motivation to engage in a task in a lab depends in part on how much we like what we see. Much research in affect perception and action perception is carried out with stimuli materials that are not designed to be particularly pleasing for participants. We therefore decided to obtain norming values of beauty and liking judgments for each stimulus in four additional online surveys. This may enable researchers from the different fields (e.g. from neuroaesthetics, affect perception, and action perception) to select stimuli from the WADAMO Library that have particularly high ratings of beauty or liking, depending on the objectives of their studies.

The following two sub-sections describe four additional norming experiments. One with Contemporary and one with Ballet dance stimuli to obtain Beauty judgments (surveys 3 and 4; section 4.1.) and one with Contemporary and one with Ballet dance stimuli to obtain Liking judgments (surveys 5 and 6; section 4.2.).

4.1. Beauty judgments

Two online norming surveys provided norming values for the variable 'beauty'; survey 3 for contemporary dance movements and Survey 4 for ballet dance movements.

4.1.1. Method – beauty judgments surveys

All studies were approved by the local ethics committee of the School of Advanced Study of the University of London.

4.1.1.1. Participants beauty judgments surveys

Twenty participants (13 male) were recruited for the contemporary dance survey (survey 3: mean age = 25.75; SD = 4.552). Another twenty participants (9 male) were recruited for the ballet dance survey (survey 4: mean age = 25.801; SD = 4.71). Recruitment was done via the online survey tool Prolific®, following the same criteria as the other online validation surveys. See table 8 for participant characteristics.

Table 8

Participant characteristics of online Contemporary and Ballet Beauty judgment surveys; surveys 3 and 4

	Online Survey 3 (Contemporary dance clips)		**Online Survey 4 (Ballet dance clips)**	
		Frequency (%)		***Frequency (%)***
Gender	Female:	7 (35%)	Female:	11 (55%)

	Male:	13 (65%)	Male:	9 (45%)
Professional dancer?	Yes:	0 (0%)	Yes:	1 (5%)
	No:	20 (100%)	No:	19 (95%)
Hobby dancer?	Yes:	7 (35%)	Yes:	4 (20%)
	No:	13 (65%)	No:	16 (80%)
Dance styles?	Social dances	5 (25%)	Social dances	5 (25%)
	Latin dances:	2 (10%)	Latin dances:	0 (0%)
	Contemporary:	3 (15%)	Contemporary:	3 (15%)
	Ballet:	2 (10%)	Ballet:	1 (5%)
	Folkloric:	1 (5%)	Folkloric:	1 (5%)
	Tap dance:	0 (0%)	Tap dance:	1 (5%)
	African dance:	1 (5%)	African dance:	0 (0%)
	Other:	1 (5%)	Other:	8 (40%)
	I don't dance:	10 (50%)	I don't dance:	13 (65%)
Ethnicity?	Caucasian:	16 (80%)	Caucasian:	17 (85%)
	Latin/Spanish:	2 (10%)	Latin/Spanish:	1 (5%)
	Asian:	1 (5%)	Asian:	0 (0%)
	Other:	1 (5%)	Other:	1 (5%)
	Prefer not to say:	0 (0%)	Prefer not to say:	1 (5%)
	Missing:	0 (0%)	Missing:	0 (0%)
First language?	English:	15 (75%)	English:	17 (85%)
	French:	0 (0%)	French:	0 (0%)
	Spanish:	3 (15%)	Spanish:	3 (15%)
	Italian:	0 (0%)	Italian:	0 (0%)
	Other:	2 (10%)	Other:	6 (30%)
	Missing:	0 (0%)	Missing:	0 (0%)

4.1.1.2. Procedure beauty judgments surveys

The procedure was exactly the same as in the main online surveys on 'Expressivity' (sub-section 3.1.2.). The only difference was the question asked: '*how beautiful does the movement look to you?*' on a slider scale from 0 (ugly) to 100 (very beautiful).

4.1.2. Results – beauty judgments surveys

Paired t-tests showed that for Contemporary dance movements, expressive movements were rated as more beautiful than the movements that were not expressive ($p = .045$), while for Ballet dance movements, paired t-tests showed that expressive movements and movements that were not expressive were rated as equally beautiful ($p = .526$). See table 9 and 10 for details.

Table 9

Results from t-tests of beauty judgments of contemporary dance clips for expressive movements and movements that are not expressive

A: RM ANOVA – Main effects – *Contemporary Dance survey (Survey 3)*
(DV: Beauty judgments)

Expressivity (IV)	*Mean*	*SE*	*t-test (1,19)*	*p*	*Cohen's d*
Not-expressive	55.841	3.873	-2.148	.045	*.23*
Expressive	57.361	3.967			

Table 10

Results from t-tests of beauty judgments of ballet dance clips for expressive movements and movements that are not expressive

A: RM ANOVA – Main effects – *Ballet Dance survey (Survey 4)*
(DV: Beauty judgments)

Expressivity (IV)	*Mean*	*SE*	*t-test (1,19)*	*p*	*Cohen's d*
Not-expressive	63.332	3.129	.646	.526	*ns*
Expressive	62.879	3.066			

4.2. Liking judgments

Two online norming surveys provided norming values for the variable 'liking'; survey 5 contemporary dance movements and survey 6 for ballet dance movements.

4.2.1. Method – liking judgments surveys

All studies were approved by the local ethics committee of the School of Advanced Study of the University of London.

4.2.1.1. Participants – Liking judgments surveys

Twenty participants (7 male) were recruited for the contemporary dance survey (survey 5; mean age = 26.65; SD = 8.47). Another Twenty participants (9 male) were recruited for the

ballet dance survey (survey 6; mean age = 27.75; SD = 4.62). Recruitment was done by means of the online survey tool Prolific®, following the same criteria as the online validation surveys. See table 11 for participant characteristics.

Table 11

Participant characteristics of online Contemporary and Ballet Liking judgment surveys; surveys 5 and 6

	Online Survey 5 (Contemporary dance clips)		**Online Survey 6 (Ballet dance clips)**	
		Frequency (%)		***Frequency (%)***
Gender	Female:	13 (65%)	Female:	11 (55%)
	Male:	7 (35%)	Male:	9 (45%)
Professional dancer?	Yes:	0 (0%)	Yes:	0 (0%)
	No:	20 (100%)	No:	20 (100%)
Hobby dancer?	Yes:	3 (15%)	Yes:	2 (10%)
	No:	17 (85%)	No:	18 (90%)
Dance styles?	Social dances	5 (25%)	Social dances	3 (15%)
	Latin dances:	2 (10%)	Latin dances:	3 (15%)
	Contemporary:	0 (0%)	Contemporary:	2 (10%)
	Ballet:	0 (0%)	Ballet:	0 (0%)
	Folkloric:	0 (0%)	Folkloric:	0 (0%)
	Tap dance:	0 (0%)	Tap dance:	0 (0%)
	African dance:	0 (0%)	African dance:	0 (0%)
	Other:	0 (0%)	Other:	2 (10%)
	I don't dance:	13 (65%)	I don't dance:	15 (75%)
Ethnicity?	Caucasian:	16 (0%)	Caucasian:	16 (80%)
	Latin/Spanish:	2 (10%)	Latin/Spanish:	2 (10%)
	Asian:	0 (0%)	Asian:	1 (5%)
	Other:	4 (20%)	Other:	1 (5%)
	Prefer not to say:	0 (0%)	Prefer not to say:	0 (0%)
	Missing:	0 (0%)	Missing:	0 (0%)
First language?	English:	17 (85%)	English:	12 (60%)
	French:	0 (0%)	French:	0 (0%)
	Spanish:	1 (5%)	Spanish:	3 (15%)
	Italian:	1 (5%)	Italian:	2 (10%)
	Other:	1 (5%)	Other:	3 (15%)
	Missing:	0 (0%)	Missing:	0 (0%)

4.2.1.2. Procedure Liking judgments surveys

The procedure was exactly the same as in the main online surveys on 'Expressivity' (Sub-section 3.1.2.). The only difference was the question asked: '*how much did you like the movement?*' on a slider scale from 0 (not at all) to 100 (very much).

4.2.2. Results – liking judgments surveys

The pattern of results was similar to the results from the beauty judgments surveys: Paired t-tests showed that for Contemporary dance movements, expressive movements were liked more than the movements that were not expressive (p = .018), while for ballet dance movements, paired t-tests showed that expressive movements and movements that were not expressive were liked equally (p = .994). See table 12 and 13 for details.

Table 12

Results from t-tests of beauty judgments of contemporary dance clips for expressive movements and movements that are not expressive

A: RM ANOVA – Main effects – *Contemporary Dance survey (Survey 5)*
(DV: Liking judgments)

Expressivity (IV)	*Mean*	*SE*	*t-test (1,19)*	*p*	*Cohen's d*
Not-expressive	48.846	3.583	-2.5798	.018	*.20*
Expressive	50.286	3.436			

Table 13

Results from t-tests of beauty judgments of ballet dance clips for expressive movements and movements that are not expressive

A: RM ANOVA – Main effects – *Ballet Dance survey (Survey 6)*
(DV: Liking judgments)

Expressivity (IV)	*Mean*	*SE*	*t-test (1,19)*	*p*	*Cohen's d*
Not-expressive	51.781	3.168	.646	.994	*ns*
Expressive	51.787	3.234			

4.3. Summary Beauty & Liking norming surveys

Participants of online surveys 3, 4 (beauty) and 5 and 6 (liking) found expressive contemporary dance movements more beautiful and liked them more than contemporary dance movements that where not expressive. Conversely, participants found expressive ballet dance movements equally beautiful and liked them the same as ballet dance movements that were not expressive.

5. Overall results of the six online surveys

This section contains visual illustrations of the results from the six online surveys as a final overview. One figure and two tables include illustrations of the results from the main surveys where expressivity ratings were obtained (surveys 1 and 2), and from the additional online surveys that provided norming values of beauty and liking (surveys 3-6). Figure 2 illustrates the results of the pair-wise comparisons of ratings to dance movements that were intended to be expressive and to dance movements that were not intended to be expressive. Participants clearly differentiated expressive from not expressive clips for both contemporary and ballet dance. For beauty and liking ratings there was a difference between contemporary and ballet dance. While for contemporary dance, expressive dance movements were found more beautiful and more likable than non-expressive dance movements, for ballet dance movements there was no such difference. Participants found expressive and not-expressive ballet movements equally beautiful and likable.

Tables 14 and 15 contain correlation matrices that illustrate how the different norming variables (expressivity, beauty, liking, luminance and motion energy) relate to each other.

Figure 2. Panels (A): Expressivity ratings for surveys 1 (Contemporary dance) and 2 (Ballet dance). Panels (B): Beauty ratings for surveys 3 (Contemporary dance) and 4 (Ballet dance). Panels (C): Liking ratings for surveys 5 (Contemporary dance) and 6 (Ballet dance).

'Expressive clips' = Clips with dance movements that were intended to be expressive; 'Not expressive clips' = Clips with dance movements that were not intended to be expressive. * $p < .05$

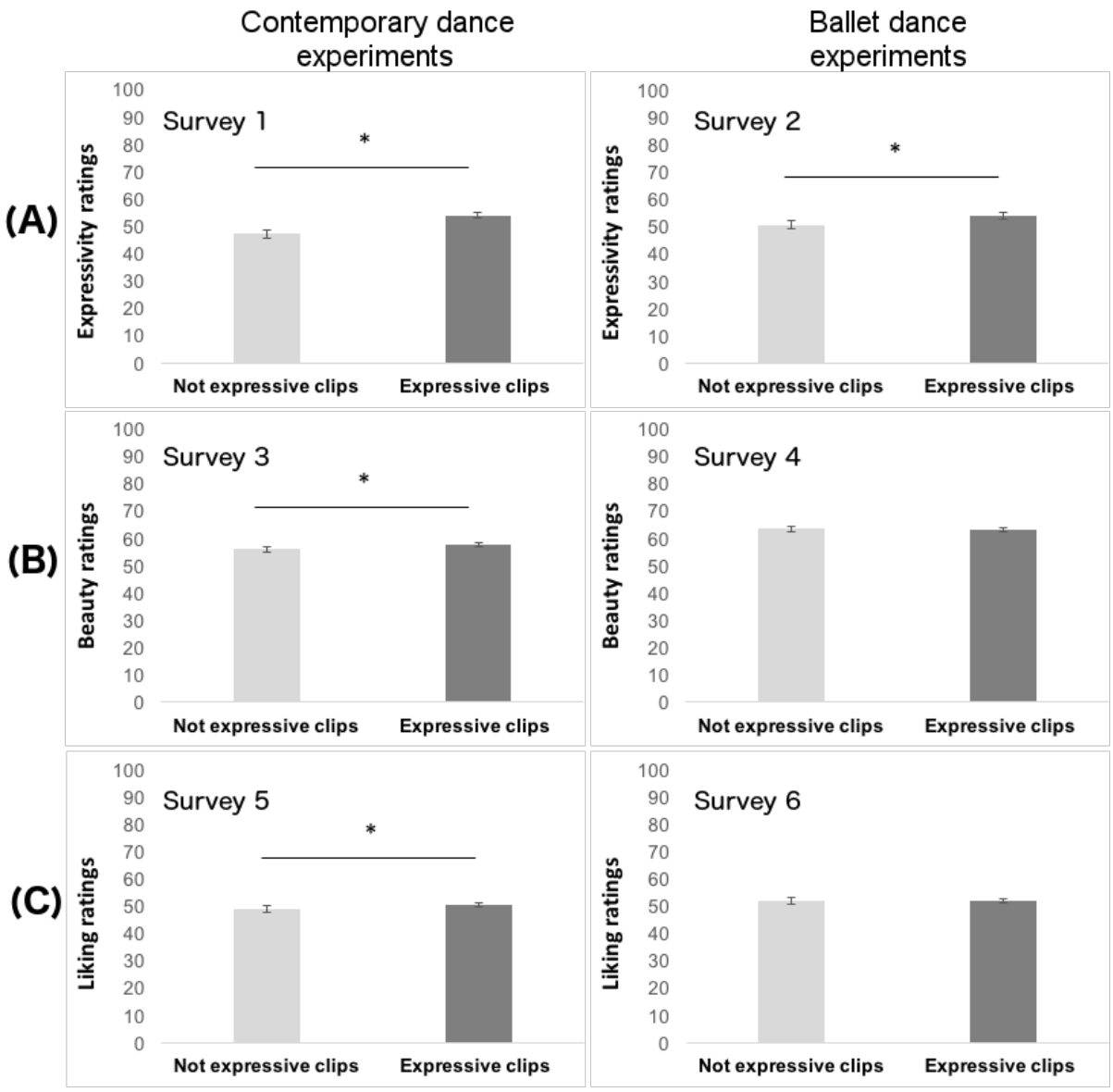


Table 14

Correlation table for Contemporary dance experiments. The three columns refer to three different correlation analyses: (1) All videos were included in the correlation, irrespectively of whether the movements were intended to be expressive or not. (2) Only Not expressive videos were included in the correlation. (3) Only expressive videos were included in the correlation. Significant p-values in bold; * p < .05; ** p < .001

Contemporary dance:		**(1) All videos**					**(2) Neutral Videos only ('Not expressive')**					**(3) Expressive Videos only**				
		Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy	Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy	Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy
All videos	Expressivity	1														
	Beauty	.105 .274	1													
	Like	.266** **.005**	.574** **.000**	1												
	Luminance	.218* **.021**	-.098 .306	.078 .413	1											
	Motion Energy	-.306** **.001**	.225* **.018**	-.200* **.035**	-.052 .588	1										
Neutral videos only ('Not expressive')	Expressivity						1									
	Beauty						.042 .811	1								
	Like						.206 .236	.609** **.000**	1							
	Luminance						.309 .071	-.058 .742	.010 .956	1						
	Motion Energy						-.120 .494	.180 .320	-.162 .354	.113 .517	1					
Expressive videos only	Expressivity											1				
	Beauty											.088 .450	1			
	Like											.272* **.017**	.552** **.000**	1		
	Luminance											.247* **.032**	-.104 .373	.136 .242	1	
	Motion Energy											-.414** **.000**	.250* **.030**	-.217 .059	-.144 .216	1

Table 15

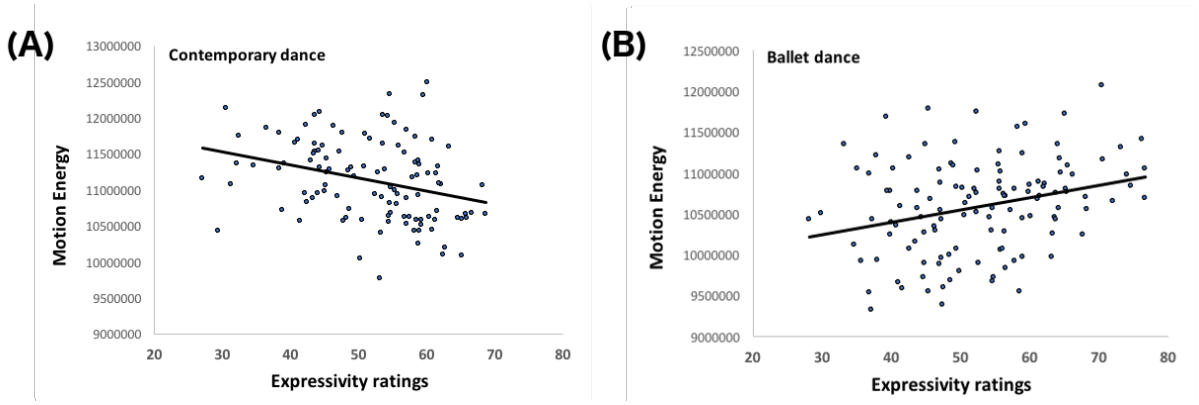
Correlation table for Ballet dance experiments. The three columns refer to three different correlation analyses: (1) All videos were included in the correlation, irrespectively of whether the movements were intended to be expressive or not. (2) Only Not expressive videos were included in the correlation. (3) Only expressive videos were included in the correlation. Significant p-values in bold; * p < .05; ** p < .001

Ballet dance:		**(1) All videos**					**(2) Neutral Videos only ('Not expressive')**					**(3) Expressive Videos only**				
		Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy	Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy	Expres-sivity	Beauty	Like	Lumi-nance	Motion Energy
All videos	Expressivity	1														
	Beauty	.431** **.000**	1													
	Like	.641** **.000**	.322** **.000**	1												
	Luminance	-.103 .258	-.250 **.005**	-.291 **.001**	1											
	Motion Energy	.288 **.001**	.003 .971	.274** **.002**	.442* **.000**	1										
Neutral videos only ('Not expressive')	Expressivity						1									
	Beauty						.255 .107	1								
	Like						.625** **.000**	.083 .608	1							
	Luminance						-.011 .944	-.175 .272	-.195 .222	1						
	Motion Energy						.435** **.004**	-.022 .889	.292 .064	.370* **.017**	1					
Expressive videos only	Expressivity											1				
	Beauty											.517** **.000**	1			
	Like											.662** **.000**	.442** **.000**	1		
	Luminance											-.139 .212	-.287** **.009**	-.341** **.002**	1	
	Motion Energy											.234* **.034**	.015 **.896**	.265* **.016**	.478** **.000**	1

Participants' ratings of expressivity distinguished adequately between dance movements that were intended to be expressive from movements that were not intended to be expressive, both for contemporary and for ballet dance videos. They found contemporary dance videos more beautiful and liked them more when the movements were expressive, while no such difference between expressive movements and movements that were not expressive was found for ballet dance movements – participants found them equally beautiful and liked them the same.

Regarding the correlations, please consult the respective tables. However, one finding to be highlighted might be that the physical property 'Motion Energy' is negatively correlated with the expressivity ratings for contemporary movements, but positively correlated with expressivity ratings for ballet dance movements. This suggests that perceived expressivity increases with less motion energy for contemporary dance, while the perceived expressivity from a ballet dance movement increases with more motion energy. See figure 3 for an illustration.

Figure 3. Illustration of the correlation between Motion Energy of the video clips and the average expressivity ratings from Surveys 1 and 2 (scale: 0 = "not expressive" to 100 = "very expressive"), for (A) contemporary dance videos and (B) ballet dance videos. The units of the motion energy variable refer to the number of pixels that changed in luminance from frame n to frame n + 1 (averaged and summed up over the video frames).



It is also interesting that the expressivity ratings are correlated with liking ratings for contemporary dance, but not for beauty ratings for this dance style. Conversely, for ballet dance, expressivity ratings are correlated with both beauty and liking judgments. This suggests that for contemporary dance, perceived expressivity enhances how much viewers like the movements, but it does not necessarily enhance how beautiful they find them. In the case of ballet movements, perceived expressivity seems to enhance both how beautiful viewers find the movements and how much they like them. For more correlations, please refer to the tables.

The supplementary material is organised in eight separate plies. Ply (1) is a description of the contents. Plies (2) and (3) contain all norming values including expressivity, beauty, liking, technical correctness, motion energy, and luminance for contemporary dance (2) and ballet dance (3). Plies (4) and (5) contain the links to each clip on YouTube where the clips can be downloaded. They also contain the embed codes that remove YouTube handles from the clips in case researchers would want to use online survey platforms such as Qualtrics. Plies (6) and (7) contain the pairs of non-expressive and expressive movements (clip a with its equivalent clip b). The final ply (8) contains all clips sorted in terms of the expressiveness ratings, irrespectively of their category (a or b).

6. Overall discussion and conclusion

The Warburg Dance Movement Library (WADAMO Library) is a normalised collection of 234 video clips of ballet and contemporary dance movements for empirical research in the fields of cognitive science and neuroscience of action perception, affect perception and neuroaesthetics. The library contains pairs of video clips of dance movement sequences. Of each pair, one version of the movement sequence is expressive (clip a), while the other version of the same sequence (clip b) is not expressive but as technically correct as the expressive version of the same dance sequence (clip a). Ratings by professional dancers confirmed that expressive and not-expressive clips do not differ in terms of technical correctness. The library was submitted to two separate online validation surveys (one for the contemporary dance and one for ballet dance) to confirm the two categories of expressive (a) and not expressive versions of the clips (b).

Overall, very high recognition scores were obtained in both surveys (as measured by the metric 'percentage of correct responses' which were = 82.1% - 92.5%), confirming the expressive quality of the dance clips (expressive and not expressive). An additional analysis in the percentage of correct responses in the two categories showed no difference between categories suggesting that participants found it equally easy to identify expressive and not expressive versions of the same movements.

Participants' years of dance experience correlated with their ratings to the clips, with their percentage of correct responses and with how much they liked the videos. Participants with dance experience also found the task less boring.

Finally, regarding the sanity checks of the data, the survey behaviour of the participants suggests that how much participants liked the clips had an effect on their performance while how bored they were of the task did not seem to alter their pattern of responses. This suggests

that including liking as a covariate might be a helpful variable to control of individual preferences while participant fatigue is not.

Summing up, we present the WADAMO Library that contains two categories of dance movements. The online surveys have provided validation values for each stimulus pair which can now be used in future experiments using dance movements as stimuli in cognitive neuroscience of action perception, affect perception and in the field of neuroaesthetics as outlined in the introduction. Additional online norming surveys provided beauty and liking ratings for each stimulus. Besides, objective values of motion energy and luminance are available for each clip.

For dance science and the arts in general, the empirical results of this normalization study confirm conjectures made by famous dancers and choreographers, such as world-famous ballet dancer Sylvie Guillem who is known to have said '*technical perfection is insufficient. It is an orphan without the true soul of the dancer*', or the renowned contemporary dancer and choreographer Martha Graham who has been quoted for saying '*great dancers are not great because of their technique, they are great because of their passion*'. The results of the present experiments show that even lay audiences are sensitive to the expressivity of dance movements – this is important for professional dancers and dancers in training, as well as for art historians and critics who debate the importance of expressivity. It is interesting to note that some differences between ballet and contemporary dance were observed, suggesting that expressivity might be particularly important in some types of dance.

Artistic activity is said to be an essentially human characteristic and the ability to create art, engage with art and express ourselves through the arts is at the core of what makes us human. Thus also in the domain of the arts, the fundamental question about expressive authenticity is paramount: is it enough for a painting, a musical piece or a dance to be technically correct to be able to move an audience? Or is something else needed – something

as ephemeral and hard to grasp for cognitive science and neuroscience – as is the expressivity of the artist? We have here provided a stimuli library which could be useful to provide answers to such questions.

The more general rationale behind the creation of such stimuli library for cognitive science and psychology research is the question about whether authenticity matters in interpersonal communication. In a culture so powered by images as ours, cognitive science needs to answer important questions about the implications for human psychology to be exposed to non-genuine expressions during social interactions. This also links to older philosophic existentialist schools of thought that proposed that 'the true and authentic self-expression' ('le vrai') is the only healthy means of interpersonal communication.

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