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Emotion matters: Different psychophysiological responses to expressive and non-expressive full-body movements

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ABSTRACT

We explore dance video clip stimuli as a means to test human observers' accuracy in detecting genuine emotional expressivity in full-body movements. Stimuli of every-day-type full-body expressions of emotions usually use culturally very recognizable actions (e.g. fist shaking for anger, etc). However, expressive dance movement stimuli can be created to contain fully abstract movements. The expressivity results from subtle variations in the body movements of the expressor, and emotions cannot be recognised by observers via particular actions (e.g. fist shaking, etc).

Forty-one participants watched and rated 24 pairs of short dance videos –from a published normalised dance stimuli library– in randomised order ($N = 48$). Of each carefully matched pair, one version of the full-body movement sequence had been danced to be emotionally genuinely expressive (clip a), while the other version of the same sequence (clip b) had been danced –while technically correct– without any emotional expressivity. Participants rated (i) expressivity (to test their accuracy; block 1), and (ii) how much they liked each movement (an implicit measure to test their emotional response ("liking"); block 2).

Participants rated clips that were intended to be expressive as more expressive (part 1: expressivity ratings), and liked those expressive clips more than the non-expressive clips (part 2: liking ratings). Besides, their galvanic skin response differed, depending on the category of clips they were watching (expressive vs. non-expressive), and this relationship was modulated by interceptive accuracy and arts experience. Results are discussed in relation to the Body Precision Hypothesis and the Hypothesis of Constructed Emotion.

1. Introduction

The expression of emotion through the body is an integral part of any social interaction, and the human brain expertly distinguishes between fake and genuine emotional expressions (McGettigan et al., 2015). Recent research in cognitive psychology and affective neuroscience attempts to measure the accurateness with which human observers detect fake and genuine emotional expressions. Much of this research has focused on facial displays of emotion and results suggest that observers are indeed aware of the subtle differences between genuine and fake (or pretend) emotional expressions of the face. One possible reason for this is a difference in movements of specific facial muscles used unconsciously when being genuine, as compared to the muscles of the face engaged during pretend emotional expressions. For instance, "fake smiles" have become known under the name "Duchenne smiles". A genuine smile engages the facial muscles *zygomatic major* and the *orbicularis oculi*, while a fake or Duchenne smile doesn't. There is something that is different depending on whether we express something due to a genuine inner feeling (Winkielman & Cacioppo, 2001), or, whether we pretend an emotion, e.g. due to a specific social context (Ambadar et al., 2005; Ambadar, Cohn, & Reed, 2009; Back, Mitchell, & Ropar, 2010; Bänziger, Mortillaro, & Scherer, 2012; Calvo, Avero, Fernández-Martín, & Recio, 2016; Krumhuber, Kappas, & Manstead, 2013; Krumhuber & Manstead, 2009; Krumhuber, Skora, Küster, & Fou, 2017; McGee, 2014; McGettigan et al., 2015; Trautmann, Fehr, & Herrmann, 2009). To our knowledge, no research has explored emotion recognition of fake and

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genuine emotional expressions in full-body movements.

The art form dance utilises this communicative power of the human body to express emotion through movement alone. Therefore, we here explore dance video clip stimuli as a means to test human observers' accuracy in detecting genuine emotional expressivity in full-body movements. Using dance movements to assess this question holds a considerable advantage over other commonly available full body video clip stimuli (e.g. Atkinson, Dittrich, Gemmell, & Young, 2004; Atkinson, Vuong, & Smithson, 2012; Keefe et al., 2014): Every-day-type full-body expressions of emotions that are used in empirical research as stimuli unfortunately contain culturally clearly recognizable cues of emotion expression (e.g. fist shaking for anger, hanging shoulders for sadness, etc), while expressive dance movement stimuli can be created to contain fully abstract movements (i.e. movements that have no clearly discernible meaning; Jaffe, 1954). In this way, the expressivity results from subtle variations in the body movements of the expressor, and emotions cannot be recognised by observers via particular actions (e.g. fist shaking, etc).

From the point of view of a dancer, "expressivity" of a dance movement means endowing it with a meaning, with an intention, instead of merely focussing on the technical correct execution of the dance move. In professional dance training, much time is spent both on the practice of technique, as well as on endowing technically correct movements with emotionally expressive intention. In this way, for instance, one simple lift of the arm can have many different expressive meanings, including functional meanings such as reaching, touching, opposing, or greeting. In addition, emotional expressivity is possible, too. With one same movement, a dancer can express sadness, anger, joy, etc. It always depends *on the way* the movement is executed. Subtle variations in the movement qualities make the difference.

Expressivity is one of the components of the definition of emotions. According to the Stanford Encyclopaedia of Philosophy, emotions have several components including appraisal (taking stock of what is in front of us; threat or safety, artwork or real world? etc), physiological response (our body's reactions; sweating, heartbeats increase? etc), subjective feeling (what do I feel?), expressivity (what is my face and my body expressing during the episode?), and behaviour (what do I do?). In the context of empirical aesthetics, emotional expressivity is one of the qualities inherent to an artwork (here, a dance) that one might appreciate during an aesthetic experience (Jaffe, 1954; Mackrell, 2019).

Empirical aesthetics is a scientific discipline, that is based on the philosophical field of aesthetics. Empirical aesthetics studies the principles governing observers' reactions and appreciations to aesthetic materials (these are often artworks, but can also be nature scenes, architecture, etc., thus, englobing "art works" under a broader definition). According to one prominent model in empirical aesthetics (Leder et al., 2004), the outcome of an aesthetic experience are aesthetic judgments (including ratings of "liking", "beauty", etc.), and aesthetic emotions. One of the main components of the aesthetic experience are the perceptual analyses that arise from the characteristics of the artistic stimulus. Expressivity is likely picked up at this stage of the aesthetic receptive process (Dutton, 2003; Gracyk, 2009).

In our case, half of the stimuli were created with intended emotional expressivity, and the other half, without. We hypothesised that this variation would impact participants' aesthetic experience. We aimed to measure this by means of participants' aesthetic judgment (ratings of "Liking" in part 2 of our experiment), when participants were unaware of the category of the stimulus (Expressive vs. Not-Expressive). We hypothesised that dance movements with genuine expressivity would be liked more than the same dance movements without emotional expressivity.

The contrast between fake and genuine expressivity that has been described for emotion psychology, for everyday-type of emotional expressions, mirrors a differentiation that also exists in the dance world (Jaffe, 1954; Mackrell, 2019). In formalist dance forms, the most important aspect is the beauty of the lines and shapes that the dance movement draws in space –almost independently of any expressivity. An example of such explicitly formalist dance are the ballet dance choreographies by George Balanchine (Levin, 1975). Conversely, in expressive dance, almost all that matters is that the movement be expressive, such as, for instance, in choreographies by Merce Cunningham in the contemporary dance reign. This contrast between expressive and formalist dance raises an interesting research question in the dance world: Two dance movement sequences being equal technically, but one *with* and one *without* expressivity –which sequence would audiences prefer? Many segments of the arts world contend that only genuine expression will reach the audience and result in an artwork, be it in painting, music, dance or other arts. Opera de Paris Étoile ballet dancer *Sylvie Guillem* once expressed it like this: *"Technical perfection is insufficient. It is an orphan without the true soul of a dancer"*. The expressive and communicative power of dance has been echoed in various evolutionary and anthropological texts about dance since the 19th century, including those of Charles Darwin (Darwin, 1871), Alfred Radcliffe-Brown (Radcliffe-Brown, 1922) and Edward Evans-Pritchard (Evans-Pritchard, 1928). Current theories of the function of dance contend that dance evolved to provide the individual with a tool to enhance affective experience, to re-establish psychophysiological imbalances and to increase health (reviewed in: Christensen, Cela-Conde, & Gomila, 2017b), and above all, to enhance social cohesion and communication and to improve interpersonal understanding (Dissanayake, 2009; Kaeppler, 1981; Malloch & Trevarthen, 2009; Schögler & Trevarthen, 2007). The oldest still preserved text about dance is the more than 2000-year old Indian text *Natya Shastra* which specifies, in great detail, 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). In the Western context, cited in Levin (1975), John Weaver (1712) is quoted for saying: "*in the presence of a true performer, the spectator will not only be pleased and diverted with the beauty of the performance and the symmetry of the movements, but will also be instructed by the positions, steps and attitudes, so as to be able to judge of the design of the performer. And without the help of an interpreter, a spectator shall at a distance, by the lively representation of a just character, be capable of understanding the subject of the story represented, and able to distinguish the several passions, manners or actions as of love, anger or the like*"; Levin, 1975; p. 1). Thus, considering the likely origins and functions of dance, there is some reason to assume that observers react differently to dance movements that are expressive, and like them more, than such movements that are not.

Modern affective neuroscience has shown that the comprehension of emotions and intentions expressed in everyday emotional expressions happens through neural resonance mechanisms in the brain (de Vignemont & Singer, 2006; Gallese, 2005; Gallese, Keysers, & Rizzolatti, 2004; Hurley, 2008; Niedenthal, 2007; Rizzolatti & Craighero, 2004; Uddin, Iacoboni, Lange, & Keenan, 2007), and, that the same mechanisms are engaged when the emotional expression happens through the arts (de Gelder, 2006; Freedberg & Gallese, 2007; Vittorio Gallese, 2005, 2011; Latif, Gehmacher, Castelhano, & Munhall, 2014; Leonards et al., 2007). For the art form dance, Corinne Jola and colleagues were able to demonstrate motor evoked potentials in lay audiences when watching expressive dance movements. This means that dance spectators' bodies reacted with minimal motor activity to the expressivity of a dancing body just like it reacts to everyday emotional expressivity, suggesting an embodied experience of watching dance. Importantly, stronger motor evoked potentials also correlated with a higher enjoyment of the movements that the dance spectators were watching (Herbec, Kauppi, Jola, Tohka, & Pollick, 2015; Jola et al., 2012; Jola & Grosbras, 2013; Jola, Pollick, & Grosbras, 2011). Furthermore, studies have shown that people without any dance experience are able to recognize and distinguish the following sets of emotions expressed in dance movements: (a) anger, disgust, fear, humour, sadness, heroism, love, peace, wonder, and lajya (Hejmadi et al., 2000); (b) joy, sadness, and anger (Sawada, Suda, & Ishii, 2003); (c) happiness, sadness, disgust, anger, surprise, and fear

(Dittrich, Troscianko, Lea, & Morgan, 1996); (d) sadness and happiness (Brownlow, Dixon, Egbert, & Radcliffe, 1997); (e) anger, grief, fear, and joy (Camurri, Lagerlof, & Volpe, 2003); and (f) joy, grief, anger, fear, surprise, disgust, interest, shame, contempt, sympathy, antipathy, and admiration (De Meijer, 1989). All these data suggest that the embodiment and comprehension of a dance movement is indeed universal, cross-cultural and requires no formal instruction.

Considering the above, it seems warranted that we use the art form dance (a type of expressive full-body movement) to investigate whether or not observers accurately differentiate genuinely expressive full-body movements from full-body movements that are not expressive. This question is relevant to a broad range of scientific disciplines including emotion psychology and affective neuroscience, but will also potentially have implications for practitioners such as audience researchers, dance teachers and choreographers.

In addition, we aim to investigate the contribution of interindividual differences to the subjective and bodily (i.e. "psychophysiological") experience of expressivity of a dance. Perhaps not surprisingly, dance expertise (both visual and motor expertise) increases the psychophysiological and neural responsiveness to the expressivity of a dance movement Christensen, Gomila, Gaigg, Sivarajah, & Calvo-Merino, 2016; Jang & Pollick, 2011; Kirsch, Dawson, & Cross, 2015; Kirsch, Drommelschmidt, & Cross, 2013; Sze, Gyurak, Yuan, & Levenson, 2010). Only very little research has specifically assessed interindividual differences in general population to expressive full-body movements. One study showed that the personality trait openness to experience and trait fantasy (sub-scale of the Interpersonal Reactivity Index by Davis (1980), are related to stronger embodiment responses to contemporary dance and Indian dance, as measured by preference ratings and the magnitude of motor-evoked potentials; Jola et al., 2012; Jola, Pollick, & Calvo-Merino, 2014). However, to our knowledge, evidence relating to interpersonal differences in psychophysiological responsiveness to expressivity in full-body movement in general population is still scarse, though one study by Kirsch, Snagg, Heerey, and Cross (2016) showed how *corrugator supercilii (CS)* and *zygomaticus major (ZM)* muscle activity to full-body affective dance muscles was modulated by dance experience of observers (Kirsch et al., 2016).

Another marker of interindividual differences in psychophysiological responsiveness is interoceptive accuracy. Interoception is the perceptual system integrating bodily signals arising from within the body. The learned interpretation of these signals in relation to preceding events and contextual information (Seth, 2013; Seth & Critchley, 2013), is thought to form the basis of healthy emotional and homeostatic function (Craig, 2002, 2003, 2009; Critchley, 2005, 2009; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004). Empirical evidence suggests that there are interindividual differences in interoceptive ability in general population: individuals who are more driven by exteroceptive signals in the environment (i.e., have an external focus), than by interoceptive signals from the body have poorer emotional awareness, less coping skills, suffer more self-objectification (Ainley & Tsakiris, 2013), and are more prone to develop mental disorders such as anxiety and eating disorders (Bair, Kelly, Serdar, & Mazzeo, 2012; Meier & Gray, 2014), than people who pay more attention to interoceptive signals (i.e., have an internal focus). Since differences in interoceptive ability in general population also correlate with emotional responsiveness to others' emotional expressivity, we will investigate how this variable of interindividual difference relates to responsiveness to expressivity in abstract full-body movement such as dance.

The Body Precision Hypothesis (Ainley, Apps, Fotopoulou, & Tsakiris, 2016) suggests that interindividual differences in interoceptive accuracy relate to how well an individual uses afferent signals arising from the body as an internal map of the bodily state, as a basis for emotional awareness and interpersonal emotion understanding. Since interoceptive accuracy reflects a person's trait awareness of, and tendency to be influenced by their interoceptive sensations, we aim to relate this particular variable of interindividual differences to the sensitivity to expressivity in full-body movements.

Our study, therefore, has three objectives. First, we aim to investigate whether participants are sensitive to the genuiness of expressivity in full-body (dance) movements with two measures: Participants will rate (i) expressivity (a direct measure to test their ability to detect the expressivity; block 1), and (ii) how much they like each movement (an implicit measure to test their emotional response ("liking") to expressive vs. non-expressive full-body movements. "Liking" has been proposed as a valid proxy measure of emotional engagement with a stimulus; Kringelbach & Berridge, 2010; block 2). Second, we aim to test whether expressive movements and movements that are not expressive elicit different physiological responses in participants: we will use galvanic skin response (GSR) to measure participants' physiological response to the two categories of full-body movements (expressive and movements that are not expressive). Third, we aim to test the Body Precision Hypothesis by Ainley et al. (2016) within the context of full-body expressivity perception: we will do this by obtaining participants' interoceptive accuracy as index of their physiological sensitivity. To our knowledge, no empirical test has till date been undertaken to investigate whether participants are psychophysiologically sensitive to the expressivity of abstract full-body movement, nor whether interindividual differences modulate this sensitivity. The objective of the present work is therefore to provide such test.

We use a stimuli library of full-body movements of dance video clips specifically created to contain 24 carefully matched pairs of the exact same movement sequences (12 pairs of contemporary dance and 20 pairs of ballet dance), the Warburg Dance Movement Library (the WADAMO Library; Christensen, Lambrechts, & Tsakiris, 2018[1]; (N = 48). 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).

The heart beat tracking task is the most widely used test for interoceptive accuracy (Ainley, Tajadura-Jiménez, Fotopoulou, & Tsakiris, 2012; Tsakiris, Tajadura-Jiménez, & Constantini, 2011). In this task, participants are instructed to feel and count their own heartbeats over fixed time periods (e.g., between 20 and 100 s), without physically taking their pulse. The subjectively reported count is then compared to the objectively recorded number of heartbeats (recorded with electrocardiogram; ECG). The difference between estimated and actual heart beats serves as an index of the participant's level of interoceptive accuracy (Ainley et al., 2012; Garfinkel, Seth, Barrett, Suzujum, & Critchley, 2015; Tsakiris et al., 2011). It is a well-validated measure, has a good test–retest reliability, and it discriminates well between individuals (Mussgay, Klinkenberg, & Rüddel, 1999; Werner et al., 2013). Since some qualms have been worded against the use of the interoceptive accuracy task (Desmedt et al., 2018; Ring & Brener, 2018; Zamariola, Maurage, Luminet, & Corneille, 2018), and this could be argued as a limitation of our study, we'd like to stress that in general, this task functions fine, when administered correctly and with the correct instructions (Ainley, Tsakiris, Pollatos, Schulz, & Herbert, 2020; Christensen, Calvo-Merino, & Gaigg, 2017).

We put forward the following hypotheses. Since emotional expression is a human universal, we propose that also lay audiences will be sensitive to the emotional expressivity of dance movements. Participants will therefore rate the expressive movements as more expressive (block 1) and like them more (block 2) than the movements that are not expressive, because movements that are not expressive are unnatural and do not exist in a natural social interaction: all human movement is

[1] The clips of the Warburg Dance Movement Library and the practice trials used in this study are available free for download on YouTube, on the YouTube channel of the BIAS project of the Warburg Institute London: https://www.youtube.com/channel/UCTAVChpnnjhH019EOCWIrbg/videos?sort=dd&view=0&shelf_id=0.

normally expressive, and not just “aesthetic”. Second, we hypothesise that participants’ GSR will differ, depending on whether the participants are watching expressive movements or movements that are not expressive. This hypothesis is two-tailed. Following a bottom-up reactive account, one would expect expressive movements to yield stronger physiological responses. Conversely, more recent top-down accounts of bodily responsiveness to the environment such as the Body Precision Hypothesis by Ainley et al. (2016), or Lisa Feldman Barrett’s Theory of Constructed Emotion (Feldman Barrett, 2017), would predict that physiological responses are based on prior beliefs and learning. Incoming information is processed with regards to simulations based on prior learning and this process “constructs” perception and emotion. Since human movements are normally expressive, movements that are not expressive may result in a prediction violation, and therefore, in an increase in physiological activity, as compared to instances where the movement is expressive (since such movements are in accordance with learned beliefs and simulations about the way bodies move). Third, we hypothesise that there will be a relationship between participants’ index of physiological responsiveness (IAcc) and their physiological response (GSR) to the full-body expressive movements. Following the above account on reactive versus predictive-simulative processes governing perception and emotion (bottom-up versus top-down), the hypothesis is two-tailed: this relationship may be positive, or negative.

2. Method

The study was approved by the local ethics committee of the School of Advanced Study of the University of London.

2.1. Participants

Forty-one participants (15 male) took part in the experiment (mean age = 23.15, SD = 3.53, range 18–33). Participants had an average of 2.49 years of dance experience (SD = 5.52; range: 0–23 years), 4.51 years of music experience (SD = 6.04; range: 0–18) and 2.13 years of art experience (SD = 5.02; range: 0–23). Inclusion criteria was age (18–35 years) to match the dancers’ age (the dancers in the video) roughly, and participants had to be native English speakers to grasp the meaning of the concept ‘Expressivity’. Participants were reimbursed for their time (£8/h). See Table 1 for further participant characteristics.

2.2. Stimuli & materials

Forty-eight video clip stimuli (24 emotionally expressive body movement sequences and 24 video clips of body movement that is not expressive) were selected from the Warburg Dance Movement Library (the WADAMO Library; (Christensen et al., 2018). The number of stimuli was based on previous work using 48 stimuli (Christensen et al., 2016, used 48 stimuli, and 48 control stimuli). The choice of dance style for the stimuli was motivated by the fact that studies in empirical aesthetics of dance have relied largely on only Western ballet dance stimuli (Christensen & Calvo-Merino, 2013; Christensen et al., 2016; Christensen, Gaigg, Gomila, Oke, & Calvo-Merino, 2014). Therefore, we now chose stimuli from *two* dance vocabularies, Western ballet and Western contemporary dance; 24 stimuli were ballet dance, and 24 were contemporary dance sequences.

See Table 2. See supplementary materials for the stimuli names and values, as selected from the WADAMO library.

For this selection, we relied on the norming values from the Warburg Dance Movement Library. For each of the dance categories (Ballet, Contemporary), we selected the 12 videos of each style that had received the strongest expressivity ratings in the norming experiment in, and the 12 videos that had received the lowest expressivity ratings in each dance style. Since the norming study contained expressive stimuli that had been danced with positive and negative expressivity, we made sure for the category of expressive clips that half of the selected clips within each style would be positive, and the other half, negative (6 in each style). We did not have any specific hypotheses about the different valence of the expressivity in this experiment, and we made sure that there were no differences in the expressivity ratings between the two dance styles, and between the positive and the negative expressive clips in the five important variables (1) technical correctness, (2) motion energy, (3) luminance, (4) expressivity, and (5) liking. See Table 3, for expressivity, liking, beauty and technical correctness ratings from Christensen et al. (2018), for the selection of stimuli for the present study. See the supplementary material for these analyses regarding the Luminance and motion energy (no differences between categories, all ps > .423).

The WADAMO Library contains a total of 234 dance video clips stimuli and was created with professional dancers who danced movement sequences of specifically choreographed dance so that each movement sequence would always be danced twice, once with emotional expressivity, and once without emotional expressivity. In this way, 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 and intentional as the expressive version (clip a). These stimuli were then submitted to online rating surveys where each video clip was rated in terms of the emotional expressivity by naïve observers. These independent raters rated all clips on the question ‘how expressive does the movement look to you?’ on a slider scale from 0 (not at all) to 100 (very much). The results from this survey confirmed the stimuli creation.

Of the available stimuli, we selected the 80 stimuli for the present experiment by selecting the stimuli that had received the most extreme ratings in these norming experiments, i.e., the 40 most expressive and the 40 least expressive, making sure in this selection that the selected clips ‘a’ were paired with their respective clip ‘b’. We confirmed that the two categories of stimuli (expressive vs not expressive) differed significantly for the contemporary movements ($t = 19.22$, df = 19, $p < .001$, d = 1.44), for the ballet movements ($t = 11.77$, df = 19, p < .001, d = 1.22), and for all stimuli together ($t = 18.55$, df = 39, p < .001, d = 1.29). See Table 4.

For the reader that is not expert in dance training, we should add 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 or less aesthetic. It simply is performed without any emotional intention. However, of course a dance movement (in fact, any human movement) can be intentional, effortful, forceful, and aesthetic without being emotionally expressive. See Fig. 1 for an example of the video materials.

Table 1
Participant characteristics.

Domain of expertise		Frequency (%)	
Professional dancers		2 (4.88%)	
Professional musicians		3 (7.32%)	
Professional painters		1 (2.44%)	
Hobby dancers		12 (29.27)	
Hobby musicians		15 (36.59%)	
Hobby painters		11 (26.83%)	
Experience		Average years (SD)	Range
	Dance	2.49 (5.52)	0–23
	Music	4.51 (6.04)	0–18
	Art	2.13 (5.02)	0–23

Table 2
Stimuli; $N = 48$.

		Dance	
		Contemporary	Ballet
Expressivity	Expressive	12	12
	Not expressive	12	12

Table 3
Independent *t*-tests for the different categories of clips that were selected from the WADAMO library (Christensen et al., 2018), with regards to relevant variables from the norming experiment. These analyses were carried out to confirm that the selected N = 48 stimuli were differing in expressivity as a function of their category, and that the positive-negative expressive clips would not differ between each other in any of the target variables. The data used was from the WADAMO data set (Christensen et al., 2018).

		Expressivity		Liking		Beauty		Technical Correctness	
Ballet		Neutral	Positive	Neutral	Positive	Neutral	Positive	Neutral	Positive
	m	52.67 (5.83)	63.33 (3.96)	52.25 (9.07)	57.42 (2.72)	65.81 (5.03)	69.98 (4.06)	79,92 (11.89)	83.94 (9.88)
		p < .001**		p = .197		p = .098		p = .486	
		Neutral	Negative	Neutral	Negative	Neutral	Negative	Neutral	Negative
	m	51.67 (5.82)	60.87 (7.80)	52.25 (9.01)	52.79 (5.93)	65.81 (5.03)	64.70 (5.17)	79.91 (11.89)	78.89 (7.60)
		p = .012*		p = .897		p = .674		p = .851	
		Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
	m	60.87 (7.80)	63.33 (3.96)	52.79 (5.93)	57.42 (2.72)	64.70 (5.17)	69.98 (4.06)	78.89 (7.60)	83.94 (9.88)
		p = .506		p = .113		p = .078		p = .344	
		Neutral	Expressive	Neutral	Expressive	Neutral	Expressive	Neutral	Expressive
	m	52.67 (5.83)	62.10 (6.03)	52.25 (9.07)	55.10 (5.02)	65.81 (5.03)	67.34 (5.22)	79.92 (11.89)	81.41 (8.81)
		p < .001**		p = .350		p = .473		p = .729	
Con-temporary		Neutral	Positive	Neutral	Positive	Neutral	Positive	Neutral	Positive
	m	39.83 (7.26)	54.38 (6.18)	45.03 (6.19)	46.43 (6.14)	53.65 (6.80)	53.85 (5.65)	88.08 (6.13)	89.44 (4.77)
		p = .001**		p = .658		p = .951		p = .642	
		Neutral	Negative	Neutral	Negative	Neutral	Neutral	Negative	Negative
	m	39.84 (7.26)	54.21 (9.79)	45.03 (6.18)	49.82 (2.88)	53.65 (6.81)	57.86 (8.00)	88.03 (6.13)	90.33 (5.02)
		p = .003**		p = .094		p = .260		p = .450	
		Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
	m	54.22 (9.79)	54.38 (6.18)	49.82 (2.88)	46,43 (6.14)	57.86 (7.99)	53.85 (5.65)	90.33 (5.02)	89.44 (4.77)
		p = .973		p = .249		p = .340		p = .760	
		Neutral	Expressive	Neutral	Expressive	Neutral	Expressive	Neutral	Expressive
	m	39.84 (7.26)	54.30 (7.80)	45.03 (6.19)	48.12 (4.91)	53.65 (6.81)	55.85 (6.92)	88.08 (6.13)	89.89 (4.69)
		p < .001**		p = .189		p = .440		p = .427	
Both dances		Neutral	Positive	Neutral	Positive	Neutral	Positive	Neutral	Positive
	m	45.76 (8.83)	58.85 (6.81)	48.64 (8.44)	51.92 (7.31)	59.73 (8.54)	61.92 (9.64)	84.00 (10.15)	86.69 (7.93)
		p < .001**		p = .260		p = .493		p = .428	
		Neutral	Negative	Neutral	Negative	Neutral	Negative	Negative	Negative
	m	45.76 (8.83)	57.54 (9.12)	48.64 (8.44)	51.30 (4.71)	59.73 (8.54)	61.28 (7.35)	84.00 (10.15)	84.61 (8.57)
		p = .001**		p = .319		p = .596		p = .859	
		Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
	m	57.54 (9.12)	58.85 (6.81)	51.30 (4.71)	51.92 (7.31)	61.28 (7.35)	61.92 (9.64)	84.61 (8.57)	86.69 (7.93)
		p = .693		p = .808		p = .857		p = .543	
		Neutral	Expressive	Neutral	Expressive	Neutral	Expressive	Neutral	Expressive
	m	45.76 (8.83)	58.20 (7.90)	48.64 (8.44)	51.61 (6.02)	59.73 (8.54)	61.60 (8.39)	84.00 (10.15)	85.65 (8.15)
		p < .001**		p = .167		p = .449		p = .537	

Table 4
Stimuli selection as rated in the norming study (scale: 0, not expressive to 100, very expressive).

		Dance		
		Contemporary Mean (SD)	Ballet Mean (SD)	Total average
Expressivity	Expressive	55.90 (8.62)	58.65 (7.89)	57.27 (8.27)
	Not expressive	43.10 (9.10)	49.67 (6.77)	46.37 (8.59)

2.3. Psychophysiological recordings

For the heart rate recordings, participants wore three disposable ECG electrodes in a modified lead II chest configuration: two electrodes were positioned underneath the left and right collarbone and another one the participant's lower back on the left side. The signal was recorded with a Powerlab 8/35 and a Bio Amp 132 (Powerlab, ADInstruments, http://www.adinstruments.com/) using Labchart 8 Pro software. The sampling rate was 1000 Hz and a hardware band-pass filter between 0.3 and 1000 Hz was applied.

For the skin conductance recordings, participants wore two ADInstruments Ag/AgCl finger electrodes (MLT118F) attached with Velcro straps around the phalanges of the index and ring fingers of their non-dominant hand. The signal was recorded using a Powerlab 8/35 (https://www.adinstruments.com/), a GSR Amp unit (22 mV constant voltage at 75HZ) and LabChart (v 8.1) software with a recording range of 40 μS and a sampling rate of 1 kHz.

2.4. Procedure

The experiment consisted of 4 parts. Part 1 was a 5-minute heart rate recording for heart rate variability (HRV) assessment (not analysed here). Parts 2 and 3 were the actual stimulus rating tasks. In part 2, participants rated the dance clips in terms of how expressive the movement looked to them and in part 3 participants rated how much they liked them. A custom build MATLAB script served as stimulus presentation software. For parts 2 and 3, the 80 stimuli were presented in 4 blocks, 2 blocks of ballet movements and 2 blocks of contemporary movements.

Clips were randomised within blocks and blocks were counterbalanced between participants. Previous research using different dance styles as stimuli materials have used both blocked (Christensen et al., 2018), and fully randomised presentations across dance styles (Calvo-Merino et al., 2005). In this case, we choose to present the different dance styles in blocks, as in the norming study of the stimuli library (Christensen et al., 2018). Besides, from a dance scholarly point of view, in this experiment where we ask participants for expressivity and aesthetic judgments (which is different from action perception related questions), it makes sense not to randomize the dance styles. In this way, we maintain internal consistency for the aesthetic stance, in the type of dance movements that the participants are exposed to. This increases the ecological validity of this research also from a dance scholarly point of view.

The dance clips (either contemporary dance or ballet dance clips) were displayed one by one and lasted 6–8 s each (±0–23 frames) and were faded in and out (5 frames to fade in and 5 frames to fade out) and a

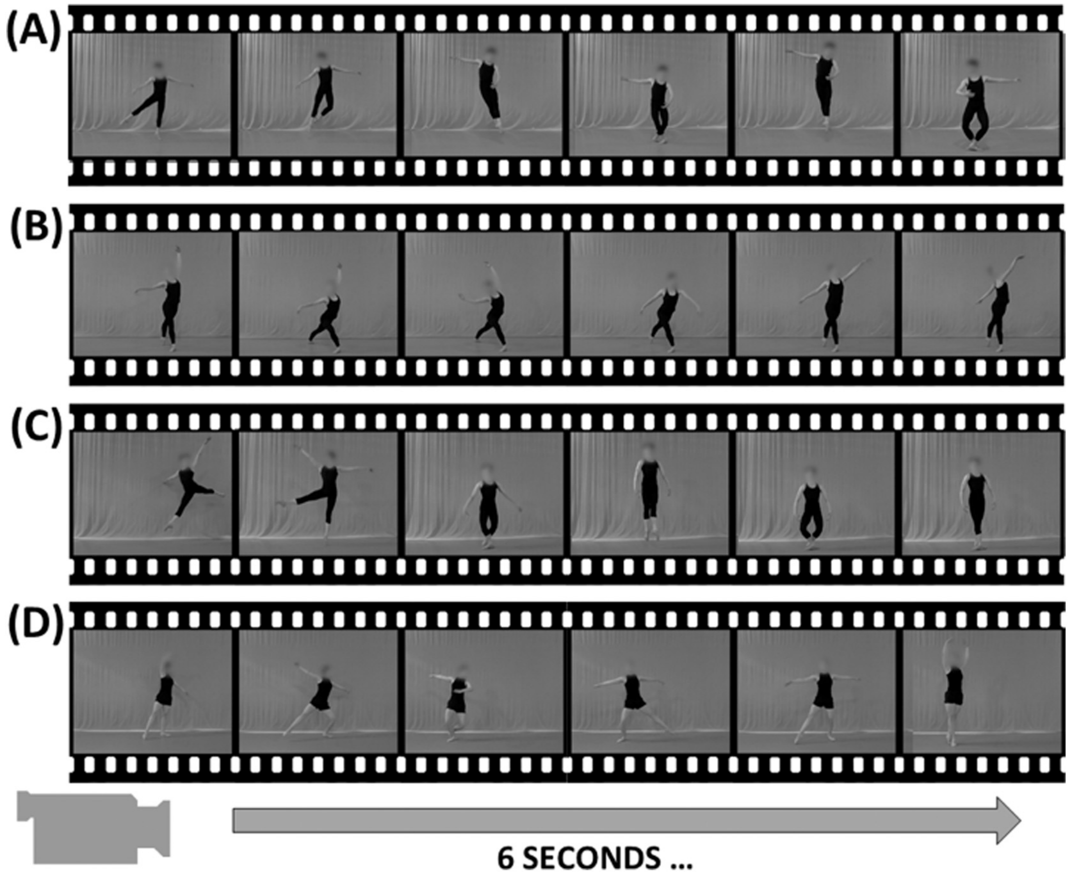

Fig. 1. Examples of dance sequences of the video Clips filmed with four dancers. The sequences contained full-body movements of eight counts, choreographed specifically for the WADAMO Library. Each video clip has a duration of about 6–8 s ± 0–23 frames. Stimuli were recorded with a frame rate of 23 frames per second. The frame rate refers to the frequency with which successive images (frames) appear in a film clip. The videos displayed in this figure are all from the Ballet category. A, B, C, D show the four dancers that participated in the stimuli creation. Video A shows Max_B7. Video B) shows Claire_B8. Video C shows Magnus_B9. Video D shows Mairi_B10.

Examples of dance sequences of the video Clips filmed with four dancers. The sequences contained full-body movements of eight counts, choreographed specifically for the WADAMO Library. Each video clip has a duration of about 6–8 s ± 0–23 frames. Stimuli were recorded with a frame rate of 23 frames per second. The frame rate refers to the frequency with which successive images (frames) appear in a film clip. The videos displayed in this figure are all from the Ballet category. A, B, C, D show the four dancers that participated in the stimuli creation. Video A shows Max_B7. Video B) shows Claire_B8. Video C shows Magnus_B9. Video D shows Mairi_B10.

4-s black screen followed the fade-out. 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?*' (Part 2) and '*How much did you like the dance movement?*' (Part 3). Answers were given on a slider scale from 0 (*not at all*) to 100 (*very much*). Stimuli were presented against a black background and occupied approximately 33.9 × 19.1 cm on the screen. GSR data was collected throughout Part 2 and Part 3. Following standard procedures (e.g., Bradley et al., 2001), the GSR data were quantified by calculating the Average Area under the Curve (in μs) within the first 6 s of the video stimulus, using the GSR analysis function implemented in Labchart (v 8.1; ADInstruments). All datapoints 1.5 standard deviations above or below the group mean were discarded (197 data points of 2016 = 9.8% of trials).

After the end of part 2 and 3, participants were asked *how much did you LIKE the task altogether?* This question was asked because it has previously been discussed that participants' motivation and responsiveness in laboratory tasks to a large extend depend on whether they like the task or not. Also considering the large intersubject variability in the appreciation of dance, we planned to include this variable specifically as a covariate in the GSR data analysis as an 'Engagement Variable'. Answers were given on a slider scale from 0 (*not at all*) to 100 (*very much*). For a similar procedure see what Baumgartner et al. (2006; *section 2.5. Psychometrical measures*) called involvement scale'.

Part 4 was the heartbeat detection task (Garfinkel et al., 2015; Schandry, 1981). Participants were asked to count their own heartbeats during six time intervals of 20, 35, 45, 50, 65 and 70 s, specifically, without physically taking their pulse. The order of presentation of these intervals was counterbalanced across participants, who were not informed about their specific durations. The task was presented via a custom-built MATLAB script. Participants were instructed to press the Enter button on the keyboard to start each trial. The word "start" then appeared, and after each interval the word "stop" appeared. The participants were then prompted to fill in their counted heart beat number (n beats reported). We employed the following commonly used formula to calculate accuracy in each trial: 1 - (|number beats real - number beats reported|)/ number beats real. An average across the six trials was also obtained for each participant. The latter value was used for the correlational analyses (Table 5).

3. Results

For an overview of the descriptive statistics of the data set, please see Table 6.

Previous research with this stimuli library showed that Dance style affected participants' ratings to the clips (Christensen et al., 2018), therefore, this factor was included in all analyses. Although our study

Table 5
(A) Expressivity: Stimuli selection as rated in the present study (scale: 0, not expressive to 100, very expressive) and (B) Liking: Stimuli selection as rated in the present study (scale: 0, I don't like to 100, I like a lot).

		Contemporary (N = 24) Mean (SD) range	Ballet (N = 24) Mean (SD) range	Total (N = 48) Mean (SD) range
Expressivity judgments		Dance		
(A)				
Expressivity	Expressive	61.88 (10.80) 45.63–75.95	57.22 *(7.00)* 42.26–66.11	59.55 (9.22) 42.26–75.95
	Not expressive	46.34 (8.17) 36.53–54.95	46.40 *(6.34)* 33.13–55.89	46.37 (7.15) 33.13–55.89
	All	54.11 (12.28) 36.53–75.95	51.80 (8.55) 33.13–66.11	52.96 (10.53) 33.13–75.95
Liking judgments		Dance		
(B)				
Expressivity	Expressive	57.73 (7.07) 48.52–70.05	58.55 (7.11) 44.15–69.08	58.14 (6.95) 44.15–70.05
	Not expressive	46.39 (4.28) 41.31–55.49	53.90 (7.70) 39.95–68.56	49.64 (6.94) 39.95–68.56
	All	52.06 (8.13) 41.31–70.05	55.72 (7.81) 39.95–69.08	53.54 (8.10) 39.95–70.05

Table 6
Summary of all contrasts of interest for the Liking ratings.

t-Tests – breaking down the interaction Dance Style * Expressivity (VAS Liking)

	Mean	SD	t-Test (1,40)	p	Cohens' d
Contemporary expressive	57.70	11.86	−0.360	0.721	*ns*
Ballet expressive	58.37	8.46			
Contemporary not expressive	46.28	9.78	−6.398	< 0.001	*1.10*
Contemporary expressive	57.70	11.86			
Ballet not expressive	52.79	9.42	−4.603	< 0.001	*0.62*
Ballet expressive	58.37	8.45			
Contemporary not expressive	46.28	9.78	−5.079	< 0.001	*0.68*
Ballet not expressive	52.79	9.42			

was not designed to test for dance, music or visual arts expertise effects on participants' ratings and GSR, Table 1 shows considerable expertise in the arts in about half our sample. We therefore coded an additional variable "Any arts expertise" as a between subjects' variable. One group with the participants that had answered "none" to all arts related questions (they had neither dance, visual arts or music experience; $n = 18$), and a second group that had answered "yes" in one or more of the arts related questions (so they had either dance, visual arts, music experience or a combination of these; $n = 22$). We performed the RM ANOVA analyses on the GSR and the Expressivity data again, with the factor "Any Art Experience" as between subjects' factor (Section 3.3.).

3.1. Behavioural ratings

A 2 × 2 RM ANOVA was computed with the VAS Expressivity ratings as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive).

Results showed a main effect of Expressivity $F(1,40) = 72.42$, $p < .001$, partial $\eta^2 = 0.644$, confirming that expressive dance movements had been rated as more expressive by the participants. There was no main effect for Dance Style $F(1,40) = 2.85$, $p = .10$, partial $\eta^2 = 0.7$, and no interaction between Dance Style and Expressivity of the clips $F(1,40) = 3.93$, $p = .054$, partial $\eta^2 = 0.089$. See Fig. 2 and summary Table 6.

A 2 × 2 RM ANOVA was computed with the VAS Liking ratings as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive).

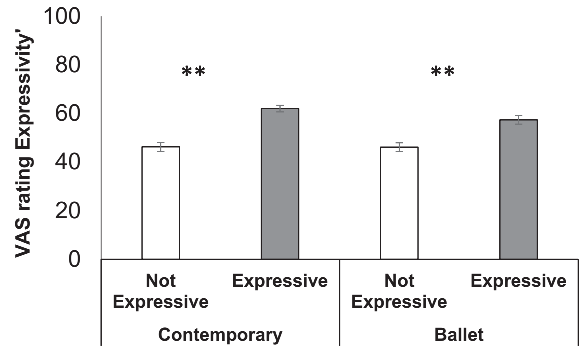

Fig. 2. ANOVA expressivity ratings. ** = $p < .001$.

Results showed a main effect of Liking $F(1,40) = 44.42$, $p < .001$, partial $\eta^2 = 0.526$, of Dance Style $F(1,40) = 6.99$, $p = .012$, partial $\eta^2 = 0.149$ and an interaction between Dance Style and Liking of the clips $F(1,40) = 12.16$, $p = .001$, partial $\eta^2 = 0.233$. To follow up this interaction, two-tailed paired *t*-tests were performed. Participants liked expressive Contemporary and Ballet videos equally, as there was no significant difference between their ratings to either of these categories ($t(40) = -0.360$, $p = .721$, ns). The pairwise comparisons within each dance style showed that participants liked expressive Contemporary dance movements more than Contemporary not-expressive movements $t(40) = -6.398$, $p < .001$, $d = 1.10$). Likewise, they liked expressive Ballet movements more than ballet movements that were not-expressive ($t(40) = -4.603$, $p < .001$, $d = 0.62$). Interestingly, participants liked the not-expressive Ballet movements more than the not-expressive contemporary dance movements ($t(40) = -5.079$, $p < .001$, $d = 0.68$). See Fig. 3 and summary Table 6.

Following the procedure from the norming study of the stimulus set, we performed several correlations on the rating data obtained from the rating tasks with these video stimuli, and their motion energy and luminance values. The correlations were performed separately for the two dance styles, and broken down into the expressivity categories (neutral, expressive). There was a correlation between expressivity ratings and liking in the case of both dance styles (Ballet clips for all videos together $p = .001$; Contemporary clips for all videos together $p = .004$). Interestingly, separately, the correlation between liking and expressivity was only significant for neutral ballet videos ($p = .041$), suggesting that for Ballet clips, liking is related to participants' perception of expressivity from the videos, also when these are neutral (but still supposedly vary, even if slightly, in terms of their expressivity). No such difference between Neutral and Expressive dance videos was found for Contemporary dance videos. There was a negative correlation between expressivity and motion energy for Contemporary dance videos ($p = .019$), and especially for expressive contemporary dance videos (p

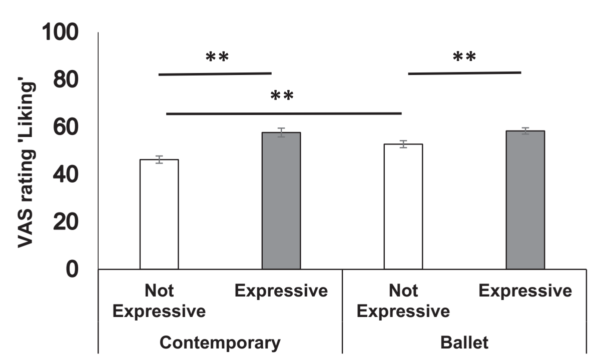

Fig. 3. ANOVA liking ratings. ** = p < .001.

= .021). No correlations between the above variables and GSR were significant (all ps > .121). See Tables 7 and 8 for the results.

3.2. Psychophysiological measurements

A 2×2 RM ANOVA was computed on the Average Area Under the Curve (AUC) of the GSR data as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive). It has previously been shown that participants' GSR is influenced by their engagement with the task. Therefore, we had obtained an overall Liking rating for the experiment in general to measure peoples' engagement with the task ('Engagement variable'). We now included this variable in the ANOVA as a covariate. Results showed a main effect of Expressivity $F(1,40) = 12.90$, $p = .001$, partial $\eta^2 = 0.249$ and of Dance Style $F(1,40) = 11.23$, $p = .002$, partial $\eta^2 = 0.224$. There was no interaction between Dance Style and Expressivity of the clips $F(1,40) = 4.14$, $p = .524$, partial $\eta^2 = 0.010$. The Engagement variable (final liking rating) interacted significantly with both Dance Style $F(1,40) = 9.52$, $p = .004$, partial $\eta^2 = 0.196$ and with Expressivity $F(1,40) = 11.92$, $p = .001$, partial $\eta^2 = 0.234$, suggesting that how much participants liked this experiment in general had a differential effect on their physiological response to the clips, depending on Dance Style and Expressivity category. There was no 3-way interaction of Dance Style*Expressivity*Engagement Variable $F(1,40) = 2.57$, $p = .615$, partial $\eta^2 = 0.007$ and there was no main effect of the Engagement Variable $F(1,40) = 988$, $p = .326$, partial $\eta^2 = 0.025$. See Fig. 4 and summary Table 9.

Next, we obtained the correlation coefficient between participants' expressivity ratings and their GSR to each clip. According to emotion theories, response coherence between the two channels of emotional experience (subjective emotional report and objective physiological response) is thought to provide an indicator of affective sensitivity and well-being in general (Christensen et al., 2016; Sze et al., 2010). In this study, we were interested in understanding how the magnitude of the response coherence between the two channels is mediated by the ability to monitor own interoceptive states. For this, we first computed the correlation coefficient between participants' expressiveness ratings and their GSR (i.e. subjective report and physiological response to the clips) to each video. We choose the expressivity ratings (part 1) and not the liking ratings (part 2), because out main hypotheses regarded expressivity, and because "response-coherence" implies simultaneous measure of subjective and physiological channels. Our GSR data was obtained during the expressivity ratings, not during the liking ratings. Then, we correlated this correlation coefficient of subjective-objective response coherence with the interindividual difference measure interoceptive accuracy, obtained by means of the heartbeat detection task (Garfinkel et al., 2015; Schandry, 1981; see Section 2.4. Procedure for a description of this task, data extraction and treatment). The objective of this procedure was to test, whether participants' interoceptive accuracy modulates the extent to which their subjective ratings of expressivity and the psychophysiological responsiveness (GSR) are coupled. We found a significant, positive relationship ($p = .014$, $r = 0.383$). The more interoceptively accurate the participants were (i.e. higher interoceptive accuracy), the more positive was the correlation coefficient (i.e. the association between the reported movement expressivity and psychophysiological responsiveness to each clip). See Fig. 5.

3.3. Arts expertise

To explore the influence of arts expertise on the behavioural and physiological responses of our participants, we coded an additional variable "Any art experience" to obtain 2 groups: One group with participants that had answered "none" to all arts related questions (they had neither dance, visual arts nor music experience; $n = 18$), and a second group that had answered "yes" in one or more of the arts related questions (i.e. they had either dance, visual arts, music experience or a combination of these; $n = 22$). We performed the RM ANOVA analyses on the behavioural ratings of Expressivity and Liking, and on the GSR again, with the factor "Any Art Experience" as between subjects' factor.

Table 7
Ballet dance stimuli correlations. The table shows the correlations for ballet dance videos of participants' subjective responses for Expressivity and Liking, and for the physical parameters of the clips Luminance and Motion energy. The table shows the correlation separately for (a) all (ballet) videos, (b) neutral (ballet) videos, and (c) expressive (ballet) videos.

		(a) All videos				(b) Neutral videos				(c) Expressive videos			
		Expres-sivity	Liking	Lum-inance	Motion Energy	Expres-sivity	Liking	Lum-inance	Motion Energy	Expres-sivity	Liking	Lum-inance	Motion Energy
All videos	Expressivity	1											
	Liking	0.648**0 .001	1										
	Luminance	−0.0210 .922	−0.3760 .070	1									
	Motion energy	0.0750 .726	0.2320 .274	0.429*0 .036	1								
Neutral videos	Expressivity					1							
	Liking					0.595*0 .041	1						
	Luminance					0.0210 .949	−0.3950 .203	1					
	Motion energy					0.1120 .730	0.0070 .982	0.5640 .056	1				
Expressive videos	Expressivity									1			
	Liking									0.5640 .056	1		
	Luminance									0.0550 .866	−0.3520 .262	1	
	Motion energy									0.1470 .648	0.4610 .131	0.3570 .255	1

Note. The three columns refer to three different correlation analyses: (a) All videos were included in the correlation, irrespective of whether the movements were intended to be expressive or not. (b) Only not-expressive videos were included in the correlation. (c) Only expressive videos were included in the correlation. Significant p values are given in bold. And the Pearson's r-statistic is marked as thus.

* $p < .05$.

** $p < .001$.

Table 8
Contemporary dance stimuli correlations. The table shows the correlations for Contemporary dance videos of participants' subjective responses for Expressivity and Liking, and for the physical parameters of the clips Luminance and Motion energy. The table shows the correlation separately for (a) all (Contemporary) videos, (b) neutral (Contemporary) videos, and (c) expressive (Contemporary) videos.

		(a) All videos				(b) Neutral videos				(c) Expressive videos			
		Expres-sivity	Liking	Lum-inance	Motion Energy	Expres-sivity	Liking	Lum-inance	Motion Energy	Expres-sivity	Liking	Lum-inance	Motion Energy
All videos	Expressivity	1											
	Liking	0.566**0 **.004**	1										
	Luminance	0.0920 .669	−0.3240 .122	1									
	Motion energy	−0.477*0 **.019**	−0.2950 .162	−0.1540 .472	1								
Neutral videos	Expressivity					1							
	Liking					−0.2740 .389	1						
	Luminance					0.4720 .121	−0.2750 .386	1					
	Motion energy					−0.3300 .294	0.1470 .649	−0.2450 .443	1				
Expressive videos	Expressivity									1			
	Liking									0.4140 .180	1		
	Luminance									0.0630 .847	−0.3760 .229	1	
	Motion energy									−0.653*0 **.021**	−0.5310 .076	−0.1150 .722	1

Note. The three columns refer to three different correlation analyses: (a) All videos were included in the correlation, irrespective of whether the movements were intended to be expressive or not. (b) Only not-expressive videos were included in the correlation. (c) Only expressive videos were included in the correlation. Significant p values are given in bold. And the Pearson's r-statistic is marked as thus.

* $p < .05$.

** $p < .001$.

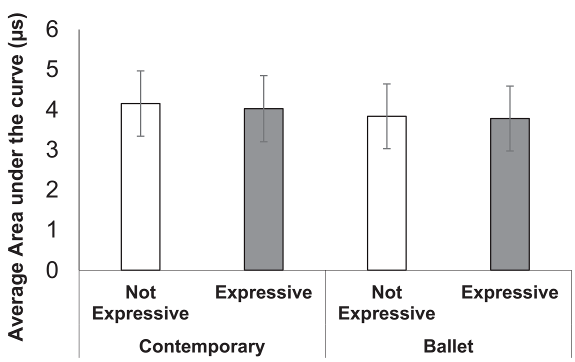

Fig. 4. ANOVA AUC GSR. Significance levels not indicated as the covariate is not represented here. Without the covariate the main effects were not significant (Expressivity: $p = .387$; Dance Style: $p = .217$; Expressivity*Dance style: $p = .579$).

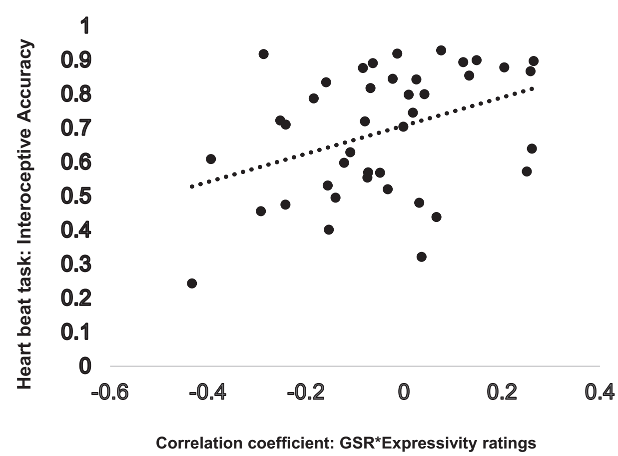

Fig. 5. Correlation between interoceptive accuracy and the correlation coefficient between physiology (GSR) and subjective ratings to the clips.

Table 9
Summary of all contrasts of interest for the 'Expressivity' factor.

RM ANOVA – main effects					
(Dependent variables: VAS expressivity, GSR, VAS liking – estimated marginal means)					
	Mean	SE	F-test (1,40)	p	η^2
Dependent variable 1: VAS expressivity					
Not-expressive	46.21	1.56	72.42	<0.001	*0.644*
Expressive	59.70	1.13			
Dependent variable 2: GSR (+ 'engagement' as co-variate)					
Not-expressive	3.96	0.86	12.90	0.001	*0.249*
Expressive	3.90	0.80			
Dependent variable 3: VAS liking					
Not-expressive	49.54	1.36	44.42	<0.001	*0.526*
Expressive	58.04	1.31			

3.3.1. *Expressivity ratings*

A 2 × 2 × 2 RM ANOVA was computed with the VAS Expressivity ratings as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive), and with "Any Art Experience" as between subjects' factor.

As before, results showed a main effect of Expressivity $F(1,40) = 70.02$, $p < .001$, partial $\eta^2 = 0.642$, expressive dance movements were rated as more expressive by the participants. There was no main effect for Dance Style $F(1,40) = 2.62$, $p = .104$, partial $\eta^2 = 0.06$, and no interaction between Dance Style and Expressivity of the clips $F(1,40) = 3.60$, $p = .065$, partial $\eta^2 = 0.085$. There was no main effect of the Between Subjects Variable "Any Arts Experience" $F(1,40) = 0.40$, $p = .529$, partial $\eta^2 = 0.01$, indicating that Arts Experience did not impact Expressivity ratings.

3.3.2. Liking ratings

A 2 × 2 × 2 RM ANOVA was computed with the VAS *Liking* ratings as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive), and with "Any Art Experience" as between subjects' factor. Results showed, as before, a main effect of Dance Style $F(1,40) = 8.09$, $p = .007$, partial $\eta^2 = 0.172$, and a main effect of Expressivity $F(1,40) = 42.49$, $p < .001$, partial $\eta^2 = 0.521$. However, the interaction between Dance Style and Liking of the clips was not significant anymore $F(1,40) = 3.61$, $p = .065$, partial $\eta^2 = 0.085$. There was no main effect of the Between Subjects Variable "Any Arts Experience" $F(1,40) = 0.40$, $p = .529$, partial $\eta^2 = 0.01$. None of the interactions between the two within-subjects' factors and the between-subjects variable were significant (all $ps > .17$), indicating that Arts Experience did not impact liking ratings.

3.3.3. GSR average area under the curve

A 2 × 2 × 2 RM ANOVA was computed on the Average Area Under the Curve (AUC) of the GSR data as dependent variable and with the factors Dance Style (contemporary, ballet) and Expressivity (not expressive, expressive) as within-subjects factors, and "Any Arts Experience" as between-subjects factor, plus the 'Engagement variable' as covariate.

Results showed a main effect of Expressivity $F(1,40) = 17.57$, $p < .001$, partial $\eta^2 = 0.316$ and of Dance Style $F(1,40) = 11.59$, $p = .002$, partial $\eta^2 = 0.234$. There was no interaction between Dance Style and Expressivity of the clips $F(1,40) = 0.152$, $p = .699$, partial $\eta^2 = 0.004$. There was no main effect of the Between Subjects Variable "Any Arts Experience" $F(1,40) = 0.53$, $p = .470$, partial $\eta^2 = 0.014$.

There was a significant interaction between Any Arts Experience and Expressivity $F(1,40) = 4.33$, $p = .044$, partial $\eta^2 = 0.102$; but not between Any Arts Experience and Dance Style $F(1,40) = 0.561$, $p = .46$, partial $\eta^2 = 0.015$.

To follow up the interaction (Any Arts Experience * Expressivity), a RM ANOVA was performed on the Average Area Under the Curve (AUC) GSR data as dependent variable, for each group (With and without Arts Experience) with the factor Expressivity (not expressive, expressive) as within-subjects factor, and with the 'Engagement variable' as covariate.

For the group *without arts experience,* there was no significant difference between Expressive and Not Expressive videos in participants' GSR, $F(1,16) = 0.031$, $p = .863$, partial $\eta^2 = 0.002$. We then explored the correlation between participants' correlation coefficient (subjective ratings of expressivity and the psychophysiological responsiveness; GSR) and their interoceptive accuracy. For this group *without arts experience*, there was no correlation, neither between interoceptive accuracy and expressive clips' expressivity ratings ($p = .358$, $r = 230$), nor between interoceptive accuracy and not expressive clips' expressivity ratings ($p = .602$, $r = 0.132$), nor between Interoceptive accuracy and the overall correlation coefficient for all clips ($p = .438$, $r = 0.195$).

For the group *with arts experience*, there was a significant difference between Expressive and Not Expressive videos in participants' GSR, $F(1,21) = 20.83$, $p < .001$, partial $\eta^2 = 0.498$, see Fig. 6. We then explored the correlation between participants' correlation coefficient (subjective ratings of expressivity and the psychophysiological responsiveness; GSR) and their interoceptive accuracy. For this group *with arts experience*, there was no correlation for expressive clips ($p = .07$, $r = 0.384$), but for the not expressive clips ($p = .019$, $r = 0.483$), suggesting that the higher participants' interoceptive accuracy, the more they were sensitive to the oddness of the not expressive clips. The correlation between Interoceptive accuracy and the correlation coefficient for all clips was also significant ($p = .007$, $r = 0.550$).

4. Discussion and conclusion

In accordance with our hypotheses, the participants of our study perceived the expressive full-body movement clips as more expressive and liked expressive clips more than the non-expressive full-body movement clips, for both contemporary and for ballet dance. This replicates previous work showing distinct behavioural ratings for expressive vs. non-expressive full-body dance movements (Christensen et al., 2018). In addition, participants' physiological responses to the clips (GSR) differed, depending on the type of clip they were watching (expressive movements or movements that were not expressive): higher GSR was observed when participants saw clips of movements that were not expressive. Finally, we explored whether response coherence between the two channels of emotional experience (subjective emotional report and objective physiological response) was related to the interindividual difference measure of affective sensitivity, interoceptive accuracy, and we found a significant positive relationship.

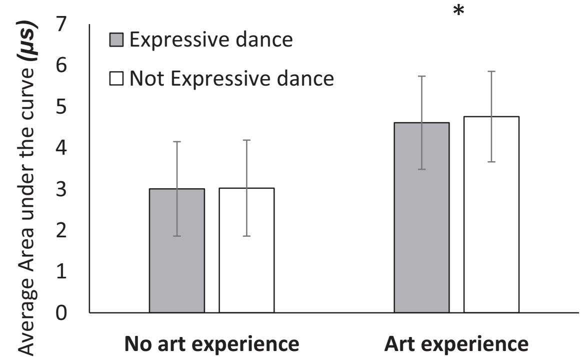

Fig. 6. Average and S.E.M. Group comparison between participants with and without arts experience. GSR Average Area Under the Curve for Expressive and Not Expressive clips. (* = $p < .05$). Please note that the ANOVA reported above included the Engagement Variable as covariate, which is not illustrated in this graph.

Regarding the psychophysiological results of higher GSR to full-body movements that are not expressive, it is true that in empirical and neuroaesthetics, much research has reported that higher liking ratings to artworks and music result in *higher* physiological and neural responses (Blood & Zatorre, 2001; Salimpoor, Benovoy, Longo, Cooperstock, & Zatorre, 2009) – though note that these effects were only found when self-chosen music was used, and the subjective rating scale that was used was "liking", a very different emotional quality, than, "expressiveness" as was used in our study. In the present study, we found a higher physiological response for stimuli that were less expressive and liked less. Our additional analysis including arts experience as a group factor then showed that this was specifically true for people with arts experience. One previous study with dance expertise has shown such interindividual differences in psychophysiological responses (electromyography, EMG), with dancers showing stronger facial emotional mimicry to dance movement displays, than participants without dance experience (Kirsch et al., 2016). However, that study did not include different categories of emotional dance movements, while our study specifically contrasted video samples of the same movements, performed either emotionally expressive, or just technically correct (not emotionally expressive).

While this higher GSR response to not expressive movements might at first seem counterintuitive, we believe, it is not. We interpret this in the light of the following evidence. Previous work usually has contrasted physiological responses to different categories of *expressive* stimuli (e.g. different emotions). For instance, different expressive emotional dance movements accompanied with sound or with congruent or with incongruent music (Christensen et al., 2014; Reason et al., 2016), live versus recorded dance (Jola & Grosbras, 2013), or to edited versus not edited dance videos (Herbec et al., 2015; Jola et al., 2013). This means that in these studies, all dance movements were expressive (or in some other way of one same category, e.g. see also (Jola et al., 2011) where participants watched an entire dance performance), but that different aspects of the delivery of the movements to the spectators varied.

Conversely, our study specifically contrasted participants' responses to dance movements that were expressive, to participants' responses to versions of the same dance movements without expressivity.

As a further note to explain the higher GSR to non-expressive full-body dance movements, we can consider the likely origins and functions of dance as expression and communicative tool, outlined in the introduction. There is, thus, some reason to assume that observers react differently to such dance movements that are not expressive. Such movements simply look slightly odd or robotic, even to people without dance experience, since they are merely technically correct executions of movement patterns that lack any sort of expressivity that is normally part of these types of movement patterns called "dance". This would be in line with the Theory of Constructed Emotion (Feldman Barrett, 2017), since movements that are not expressive violate prior predictions about body movement (likewise for dance movements or every-day-type movements such as walking, running or throwing a ball). In this view, participants would pick up the 'oddness' of the movements that are not expressive and this is indexed by a higher GSR specifically to these movements, that are also liked less in our data set. Previous work has shown enhanced GSR for liked stimuli, however, these were mostly obtained with participant-chosen stimuli materials. It is unlikely that our stimuli library of dance movements should yield strong enough affective responses to cause measurable GSR changes. Rather, our study design taps into the contentious issue about whether or not our body's physiology is sensitive to subtle variations in genuine expressivity of an affective movement.

The lower GSR for expressive movements could signal increased fluency processing, since these moves were also liked more (Reber, Schwarz, & Winkielman, 2004; Ticini & Omigie, 2013) (even if it should be said that the liking ratings were obtained in the second part of the experiment, while the GSR-expressiveness ratings analysis refers to the data in part 1 of the experiment; i.e. the GSR and liking data were not obtained simultaneously). Previous work with liking ratings as subjective reports about affective stimuli have reported higher physiological responses for liked displays (Chenier & Winkielman, 2009), and there is work using psychophysiological assessment such as EMG that suggests that more fluent movement displays are preferred (Cannon, Hayes, & Tipper, 2010). If we consider that other research shows that the expressive, genuine emotional displays are more fluent and thus easier to process (Winkielman & Cacioppo, 2001), this would then explain why the expressive stimuli were also liked more in our dataset.

In relation to our interindividual difference measures of psychophysiological responsiveness, we obtained the correlation coefficient between participants' expressivity ratings and their GSR to each clip. According to emotion theories, response coherence between the two channels (or coupling) of emotional experience (subjective emotional report and objective physiological response) is thought to provide an indicator of affective sensitivity and well-being in general (Christensen et al., 2016; Sze et al., 2010). Normally, the coupling between physiology and subjective report is rather low (no correlation). We here explored, whether the magnitude of this coupling might be related to higher interoceptive accuracy (Christensen et al., 2017). This psychophysiological index of bodily responsiveness to the full-body movements correlated with participants' interoceptive accuracy: The higher their interoceptive accuracy, the more positive was the association between subjective ratings and GSR (i.e. the psychophysiological correlation coefficient). These results are in line with the Body Precision Hypothesis that suggests that interindividual differences in interoceptive accuracy relate to how well an individual uses afferent signals arising from the body as an internal map of the bodily state, as a basis for emotional awareness and interpersonal emotion understanding. The correlation suggests that the more interoceptively accurate individuals are also more accurate in detecting their psychophysiological responses to the expressivity of full-body movements.

An issue to be discussed in relation to this result is that the correlation coefficient of the correlation between GSR and expressivity ratings ranges from negative values to positive values and that the correlation of this coefficient with interoceptive accuracy thus passes through a correlation coefficient of "0". It seems that the more interoceptively accurate the participants were (i.e. higher interoceptive accuracy), the more positive was the correlation coefficient (i.e. the association between the reported movement expressivity and psychophysiological responsiveness to each clip). In other words, high and low interoceptively accurate participants might make different uses of bodily cues to inform subjective expressivity judgments: those with particularly high interoceptive accuracy may tend to respond with higher arousal to expressive dance, while individuals with low IAcc are more sensitive to movement prediction violations. Future assessments of interoceptive accuracy and other proxy measures of physiological responsiveness to full-body movement might explore this further. In the context of the wider emotion literature, our results are in line with the view that interoceptive arousal feedback informs the conscious experience of emotions (Niedenthal, 2007) and that embodied simulation or mimicry of behaviours and experiences of others is important both for the understanding of others' actions (Jacob & Jeannerod, 2005; Jeannerod, 2001) and their emotional states (Blackemore & Decety, 2001; Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Chartrand & Bargh, 1999; Critchley, 2005; Dapretto et al., 2006; V. Gallese, 2003; Goldman & Sripada, 2005; Molnar-Szakacs & Overy, 2006).

Our results also have interesting implications for the arts world. We provide empirical evidence that human observers of dance movements without any dance experience (or very little dance experience, cf. participant characteristics Table 1) are sensitive to the expressiveness of a dance. The participants of our study preferred expressive and technical correct movements over non-expressive but technical correct movements. Dance as any art form has always played an important role as a tool of communication of societal, political and artistic issues (e.g. (De Warren, 2009; Leigh Foster, 2009; Shay, 1999, 2002). In this way, dance helps to develop societal and individual identity, awareness, and confidence (Christensen, Cela-Conde, & Gomila, 2017a). This means that expressivity in dance is important to move audiences. Another implication of our results is for professional dance teaching, where often a trade-off must be made between technique and expressivity, as pointed out by the dance scholar and pedagogue Janet Karin OAM: "*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). Our results can potentially help to emphasise the importance of fostering genuine expressivity in dance students and not just perfect technique, since expressive movements make a difference even to lay audiences and to people with very little dance experience.

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CRediT authorship contribution statement

Conceptualization; Funding acquisition; Investigation; Methodology; Project administration; Resources: JFC & MT.

Software; Methodology: JFC & RTA.

Roles/Writing - original draft: JFC.

Writing - review & editing: JFC, RTA, MT.

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