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Research Reports

Do Free Dance Movements Communicate How We Feel? Investigating Emotion Recognition in Dance

Kommunizieren freie Tanzbewegungen wie wir uns fühlen? Untersuchung von Emotionserkennung im Tanz

Sinead White[1], Hauke Egermann*[1]

[1] York Music Psychology Group, Department of Music, University of York, York, United Kingdom.

Abstract

Current research into music and free dance movement explores differences in corporeal articulation of basic emotions. Accordingly, Van Dyck et al. (2014, https://doi.org/10.1371/journal.pone.0089773) report congruent emotion recognition in free dance movements recorded after happiness or sadness inductions in lay dancers. The current study replicates this previous study with an advanced methodological approach measuring ratings of happiness and sadness recognition separately within both happy and sad conditions. We then tested the differences between the recognition of happiness and sadness in free dance movements. Therefore, a dance movement pre-study was conducted in two different conditions where either happiness or sadness were induced within four lay dancers using guided imagery and music listening. Subsequent to this, dancers were video recorded while moving freely to a neutral piece of music. Those silenced video recordings were then presented to participants (N = 37) in an online experiment, who were instructed to rate the emotion they recognised. Based on the Effort-Shape Theory by Rudolf Laban, observers also rated kinematic features of velocity/acceleration, directness, impulsiveness and expansion. Participants rated higher levels of happiness for the happy-induction condition compared to sadness. However, participants rated higher levels of sadness in the sad condition compared to happiness for just one of the four dancers. This finding indicates that it is easier to recognise happiness in free dance movements than sadness. The results of the kinematic features supported previous research which rated higher intensities for the happy condition than the sad condition.

Keywords: dance, music, emotion recognition, embodied music cognition, motion features

Zusammenfassung

Aktuelle Forschung zu Musik und Tanzbewegungen exploriert die Unterschiede in körperlichem Ausdruck von Basisemotionen. So berichten Van Dyck et al. (2014, https://doi.org/10.1371/journal.pone.0089773) über das Erkennen von kongruenten Emotionen in freien Tanzbewegungen, die nach der Induktion von Fröhlichkeit oder Traurigkeit in Versuchsteilnehmenden aufgenommen wurden. Die aktuelle Studie repliziert diese vorherige Studie mit einem erweiterten methodologischen Ansatz, indem wir hier auch testen, ob es einen Unterschied in der Erkennung von Fröhlichkeit und Traurigkeit in Tanzbewegungen gibt. Deshalb wurde zunächst eine Vorstudie durchgeführt, in der in zwei verschiedenen Bedingungen entweder Fröhlichkeit oder Traurigkeit in vier Laien-Tänzern mithilfe von „Guided Imagery“ und Musikhören induziert wurden. Anschließend wurden Videoaufnahmen von den Tanzenden erstellt, während diese sich frei zu einem neutralen Musikstück bewegen. Diese Aufnahme wurden dann Teilnehmern (N = 37) in einem Online-Experiment vorgeführt welche instruiert wurden, die von ihnen erkannte Emotion einzustufen. Hier wurden auch kinematische Eigenschaften basierend auf der Effort-Shape Theory von Rudolf Laban bewertet: Geschwindigkeit/Beschleunigung, Direktheit, Impulsivität, Expansion. Ergebnisse für die Bewertung der kinematischen Eigenschaften bestätigen vorangegangene Forschung, in dem hier für die fröhliche Versuchsbedingung höhere Intensitäten berichtet wurden als für die traurige. Die Teilnehmenden zeigten das Erkennen von Fröhlichkeit für die fröhliche Bedingung für alle Tanzenden. Das Erkennen von Traurigkeit in der traurigen Bedingung wurde jedoch nur für eine der Tanzenden beobachtet.

Schlüsselwörter: Tanz, Musik, Emotionserkennung, Embodied Music Cognition, Bewegungsfeatures

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Begutachtet von: Guido Orgs; Birgitta Burger.
*Korrespondenzanschrift: Department of Music, University of York, Heslington, York, YO10 5DD, United Kingdom. E-Mail: hauke.egermann@york.ac.uk

Emotions, music, and dance are strongly linked within everyday life. Research has demonstrated that music evokes strong body responses (Sloboda, 1991) and subjective feelings (North & Hargreaves, 1997). Theories of embodied music cognition suggest that the human body is a natural tool that facilitates interaction with music and affective states (Leman, 2007; Levy, 1988; Niedenthal, 2007). Accordingly, Leman (2007) suggests that the body could act as a mediator between music signification (ideas, intentions, experiences, beliefs) and the physical world. When dancing to music, the human body's movement and gestures might therefore become a mechanism of embodied cognition that will allow access to a mental level of musical signification and experience (Leman, 2007). In the present study, we therefore explore if observation of free dance movements of lay dancers allows for a recognition of their current emotional state.

Dance Perception and Recognition of Emotion

Observation of dance has become a valuable tool for understanding visuomotor processing. Characteristics of dance (such as timing) often evoke certain positive or negative responses in observers (Orgs et al., 2013; Orlandi et al., 2019), indicating that dancers can control distinct patterns and shapes of dance movement to influence an individual's aesthetic experience. Accordingly, Christensen et al. (2016) find that dance elicits affective responses in observers. Their participants' ratings of valence and arousal revealed relations between roundedness and impressiveness on the one side and positive affective responses on the other. The more impressive the movements, the higher the positive ratings of affective state were. These findings are supported by the work of Cross et al. (2011) who studied neural correlates, liking ratings of movements of professional dancers' performances, judgements of their participants' own physical ability to imitate certain movements in the performance. The movements they perceived as difficult to physically perform themselves were rated higher in likability (positive response) compared to those they perceived as less difficult to perform.

Perception of emotions in dance movement has been described through linking certain qualities of dance characteristics to different emotions (Brownlow et al., 1997; Camurri et al., 2003). These studies find that patterns of dance characteristics (such as strength, fluidity, and openness) can be distinguished between different emotions. However, these studies used actors' portrayals of expressing emotion which may be fabricated and rely on intellectual processing of how someone may interpret the music and emotion. However, other research into free laymen dance movement indicates that dance could hold the capacity to reflect dancers' true inner emotional states (Levy, 1988).

In order to study the impact of inner emotional states on dance movements, Van Dyck and colleagues (2013) induced emotion in lay dancers using guided imagery in addition to happy and sad music, following previous research indicating that music-induced emotion is equivalent to naturally occurring emotions (Juslin & Västfjäll, 2008). Here, participants self-reported felt emotion before and after listening to either happy or sad music, to test the effectiveness of the emotion induction. Then then danced freely to a neutral music stimulus. Structural characteristics of music do relate to emotion, particularly happiness and sadness (Juslin & Laukka, 2004), therefore it was deemed important to use a neutral piece of music in order to avoid effecting the emotion induction paradigm. Van Dyck et al. (2013) then studied the differences in corporeal articulation between happy and sad movement using a motion capture system. Motion capture data revealed that the two different induced emotions evoked corresponding motion features in free dance movements. In order to test Leman's (2007) theory that the body might be used as a mediator between mind and physical world, Van Dyck and colleagues (2014) subsequently used video clips from their previous study (Van Dyck et al., 2013) in an emotion recognition experiment. Here, they were able to show that observers were able to recognise induced emotions in dance movements. Additionally, they had observers rate kinematic features of the dances to examine any differences between the two emotion conditions but did not find any significant differences.

Methodology of Analysing Movement With Emotion

The Laban Effort-Shape Theory is an integrated terminology system, developed by Rudolf Laban (1950). It describes the structural and physical characteristics of movement. Effort relates to dynamics and the subtle qualities underlying movement. Those qualities are the ones that would, for example, differentiate between the movements of punching something or picking up an object (which both involve the extension of an arm). To understand the intention of an action, weight, time, flow and space need to be considered (see also Van Dyck et al., 2013):

- Weight - The dynamics of movement describing the intensity of force between strong and light. It regards whether the body is moving with velocity/acceleration or tension that would suggest increasing pressure in movement.
- Time - The duration of time taken to carry out a movement. It refers to any tempo changes, the structure of rhythm, flow of movement and impulsiveness; if there is either a lack or sense of urgency within the movement.
- Flow - The amount of control and bodily tension in the movement. It looks at the frequency/rhythm of motion, any pause phases, the fluency and freedom of movement.
- Space - The directness of movement; for example, if someone is pointing in straight directions or moving as though they are swatting away a fly. It also recognises whether limbs are contracted or expanded in relation to the centre of body.

Shape refers to the characteristics of the bodily form and how it changes in space. It looks at the breadth of the body and its expansion, as well as height rising or descending (across a vertical axis) and whether the quality of the movement is light or strong.

The experimental work by Van Dyck et al. (2013) used the Laban Effort-Shape theory to measure movement cues in association with the induced emotion. The results for happiness showed impulsive movements in chest, arms, hand and hips, faster arm and hand movements, acceleration in the head, hands, hips and feet, and limbs projected higher and further from the centre of the body. Sadness revealed the opposite result including smoother motion.

Studies by De Meijer (1989) and Camurri et al. (2003) adopt the Laban Effort-Shape theory for experimental designs that use video recordings of body movement performed by actors. Camurri et al. (2003) focused on analysis of anger, fear, grief and joy in relation to non-propositional movement rather than propositional movements that transmit meaning (for example, raising one's hand to indicate stop). Anger revealed frequent tempo changes, expanded limbs and high tension in movement. Fear also showed frequent tempo changes, yet long pauses between changes, contracted limbs and high tension. Grief had few tempo changes (smooth), and low tension. Finally, joy displayed frequent tempo changes, long pauses between movements, extended movements and dynamic tension changing between low and high.

De Meijer (1989) used a slightly different method with seven general dimensions to systematically explore any significant general movement features. Participants judged the video's compatibility with twelve different emotions. The results demonstrated that there are certain movement characteristics that can be associated with an emotion based on observational identification. Positive emotions share a commonality of dimensional features due to their common motive and action propensities. Positive qualities include stretching, openness, lightness, directness, moving towards surroundings, strength and impulsiveness. Contrasting this, negative qualities contain attributes of bowing, closing, moving downward or backward, hiding, loss of energy and slow (see also Burger et al., 2013, who applied a similar approach to investigate music-induced dance movements).

In conclusion, in most studies, happiness displays patterns of motion with high energy and dynamic tension in the body that is motivated by strength (see also Irrgang & Egermann, 2016). The weight and time demonstrate impulsiveness, velocity and acceleration, while the flow of movement, shape and relationship to surroundings presents an openness and directness with limbs projecting both upwards and further from the centre of the body. Sadness differs from this with smoother and slower motion. The motivation in the body is hindered as it shows low tension, little/no tempo changes and contraction potentially suggesting an intention of hiding.

Aims and Hypotheses

In Van Dyck's et al. (2014) study, the recordings of the dancers were presented to participants in a forced-choice emotion recognition experiment (participants choose between side-by-side dance recordings and decided which one was happy, and which was sad). It tested the odds ratio of observers reporting the emotion induced in the dancer correctly and found recognition of the correct emotion was higher than recognition of the incorrect emotion. However, the authors did not report here if there were any differences in recognition of happy and sad emotions in dance movements. Furthermore, the forced choice paradigm employed here might have created demand characteristics in participants biasing response behaviour towards the author's hypothesis.

The aim of the studies presented here are to understand whether dance movements communicate the emotions of lay dancers. Through employing a similar research design to that of Van Dyck's et al. (2014), we first evaluated if their findings could be replicated with a different participant population. Furthermore, we tested additionally if there are differences between recognising happiness and sadness from dance movements recorded in sad or happy conditions using an open response format (which does not force participants to choose between either happy or sad emotions like in the original study). Furthermore, we explored perceived kinetic features that were associated with recognised emotions. We therefore generated video recordings of emotional, free dancing in a pre-study. Here, we induced happy and sad emotions in participants by presenting emotional music and guided imagery vignettes to them. We then asked them to dance freely to emotionally neutral music while we did video recordings of their movements. Subsequently, we conducted an online emotion recognition experiment. Here, we presented silent video excerpts from these dance recordings individually to participants and asked them to rate the recognition of emotions and their perception of kinematic features: velocity/acceleration, directness, impulsiveness and expansion. Both studies have been conducted following consideration and approval from the University of York's Arts and Humanities Ethics Committee. Based on previous research, our hypotheses for this recognition experiment were:

a. Dance movements recorded in the happiness-induction condition will result in higher ratings of happiness recognition than sadness.

b. Dance movements recorded in the sadness-induction condition will result in higher ratings of sadness recognition than happiness.

c. Happy condition kinematic features will be perceived as stronger, more direct, more sudden and flexible than the sad condition features.

Pre-Study

Participants

Four participants (two females, two males) were recruited for the dance movement pre-study, ages between 21-23 years. The majority (three) had received of musical training, with an average of 3.5 years (SD = 4.4). One participant had dance training (17 years). Overall participants rated their dance activity to be part of their lives with an average of 3.5 (SD = 1.0, on a 5-point Likert scale, 1 = *not at all* to 5 = *yes, definitely*). Each participant gave consent to be part of the pre-study, and additional consent for their video-clips to be used in the recognition experiment.

Guided Imagery Vignettes

The vignettes are short description of different scenarios designed to evoke imagery (see Appendix A). They were created to induce the desired emotional states happiness and sadness that were based on a selection of articles, both with examples of happy and sad vignettes (Lagotte, 2014; Mayer, 1990), and narratives of each emotion (Diener, 1984; Lazarus, 1999). To decide what vignettes would be appropriate to use, a pre-test questionnaire was presented to 20 judges. This included 20 vignettes (10 happy, 10 sad) that were revealed in random order and rated by the judges on a five-point Likert scale (1 = *not at all* to 5 = *a lot*) of *happiness* and *sadness*. The final chosen 16 vignettes were based on whether they were rated four or higher for the intended emotion (see Appendix A). The results revealed that the happy emotion vignettes average was rated between 4 and 5 (M = 4.4, SD = 0.74) for happiness and near 1 (M = 1.29, SD = 0.55) for sadness. For the sad emotion vignettes, they were rated on average between 4 and 5 (M = 4.3, SD = 0.92) for sadness and near 1 (M = 1.12, SD = 0.49) for happiness.

Musical Stimuli

Four music stimuli (two happy, two sad) were chosen based on previous studies and their success in inducing happiness and sadness (Guhn et al., 2007; Khalfa et al., 2008; Van Dyck et al., 2013, 2014; Weth et al., 2015). To enhance the likelihood of inducing the emotion intended, the pieces were chosen based on familiarity and general popularity, strengthening intensity of occurring emotions (Kreutz et al., 2008). In the happy condition, the original versions of two musical excerpts were used: Carnaval des animaux (Finale) from Saint-Saens and Eine Kleine Nachtmusik in G Major (1st mvt) by Mozart. For the sad condition, we used the theme from Schindler's List by John Williams and Adagio in G minor by Albinoni.

In Van Dyck et al. (2013), the researchers aimed to create "neutral music" by composing a piece choosing characteristics of the tempo, timbre, harmony and style that avoided expressing basic emotions. Accordingly, they produced a music piece that was not too fast (evading a happy experience) or too slow (a sad experience); 120 beats per minute (BPM) and alternated between major (happy) and minor (sad) chords so there was no consistency of harmony. In addition, the timbre was chosen to avoid sounding too harsh, moving away from any intense emotion, and no vocals were used to avoid influence of lyrics. The aim was to create a setting of everyday life, using a modern dance music style, so the stimulus was ecologically valid. A recording of this piece of music was requested from Van Dyck et al. (2013) and used for both dance conditions in our study.

Procedure and Measures

The pre-study was undertaken in a dim-lit room with no windows to avoid any outside distractions or influences, controlling any situational variables. Participants were asked to wear clothing that was flexible for ease of movement, and plain to avert distractions for observers in the subsequent emotion recognition experiment. Each participant was exposed to both conditions randomly; half of them starting with the happy condition and the other half the sad condition. They freely danced in each condition on separate sessions with a period of at least three days apart to avoid any influence of one condition on the other.

Each session consisted of a four-part process:

a. Emotion ratings of current felt emotions

b. Emotion induction procedure (reading vignette and listening to music)

c. Free-dance movement (to neutral music)

d. Repeat of emotion ratings

Upon arrival, participants were asked to read information on the study and sign consent to the experiment. Following this, they were given a verbal explanation of the basic process of the experiment. The first part of the experiment would then start with participants rating their current felt emotion. They were presented with a list of 18 emotions that were measured on a 5-point Likert scale (1 = *not at all*, 2 = *slightly*, 3 = *moderately*, 4 = *very*, 5 = *extremely*) to document the felt emotion participants were experiencing of sadness and/or happiness before the emotion induction began. Using the work of Van Dyck et al. (2013), sadness was represented with the words "sad", "blue" and "downhearted", while happiness was described by "happy", "joyful" and "cheerful". The other 12 emotions (see Appendix B) listed were to disguise the purpose of the experiment.

After they had completed the felt-emotion ratings, participants began the emotion induction section. They started by listening to musical stimuli (through headphones) whilst rating eight guided imagery vignettes (rated highest in the pre-test) for each condition on a 5-point Likert scale (1 = *not at all* to 5 = *a lot*) of the emotions happiness, sadness, anger and fear (results not shown).

The free-dance movement section followed. Participants were asked to stand in front of a partially hidden camera where recording would begin. They were told that the music would be for around 50 seconds, that no one would be watching, and they could begin dancing freely whenever they felt comfortable enough to do so. This method proves to be a more ecologically valid approach than using actors, as actors could create an exaggeration of expressing emotion that does not accurately represent everyday life (Van Dyck et al., 2014).

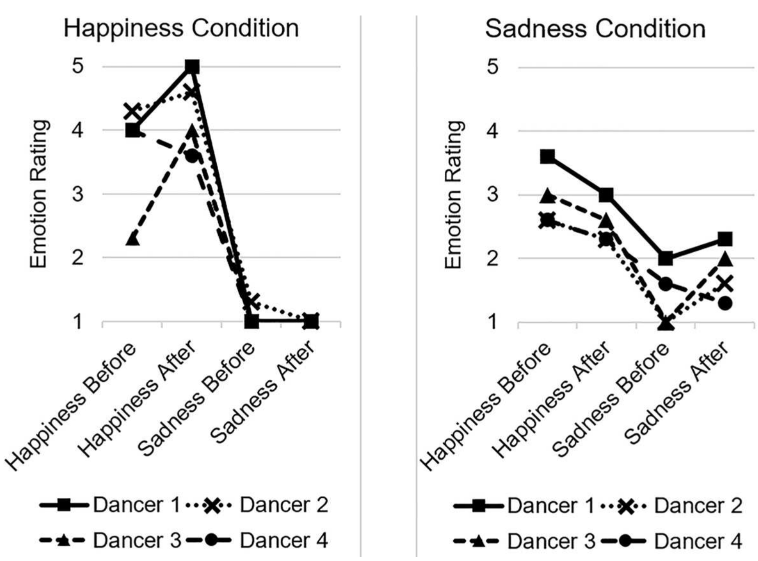
Finally, the participants would repeat the emotion rating and fill out their socio-demographic details including music training and dance training/activity.

Results

In the happy condition happiness ratings increased in most dancers (Figure 1), while sadness ratings decreased or did not change. Sadness ratings increased for dancers in the sadness condition, while happiness ratings decreased or did not change. The increase in the induced emotion of happiness appears to be larger in the happy condition, compared to the increase of sadness in the sad condition. These general patterns could be observed for Dancers 1,2, and 3, however not for Dancer 4, whose ratings did not respond to the emotion-induction procedure strongly. Furthermore, in both conditions for all dancers, happiness was rated higher than sadness.

Figure 1

Felt Happiness and Sadness Ratings Separated by Dancers and Condition Before Versus After Emotion Inductions



Method

Dance Movement Video Stimuli

Based on previous research and studying the differences in corporeal articulation between happy and sad conditions (Camurri et al., 2003; De Meijer, 1989; Van Dyck et al., 2013, 2014), we were able form a criterion on which to base the video stimulus production. As stated previously, happy conditions showed elements of more acceleration, impulsiveness and faster movement than sadness. Additionally, based on the theory of shape, happy conditions also reveal expansion and limbs projected higher and further from the centre of the body, whereas sad condition movements were contracted and closer to the centre of the body. Using this knowledge, the video recordings of the pre-study were analysed through qualitative observation of the first author of this manuscript. Sections showing examples of kinematic features that could support the recognition of both happy and sad emotions were identified that way. Cutting the recordings into 8 ten-second-long clips (two excerpts for each of the four dancers) allowed for plenty of examples of the kinematic features from the Laban Effort/Shape theory to be presented in an online experiment that was supposed to last only a few minutes.

Measures and Procedure

The dance movement videos were embedded in the online questionnaire (programmed in Qualtrics) and presented to viewers in a randomised order. The silent clips were rated on both happiness and sadness on a unipolar visual analogue scale, coded 1-100, which displays horizontal lines to measure the intensity of emotion on a metrical basis. The questionnaire also included ratings for kinematic features (also on unipolar visual analogue scale, coded 1-100), based on the Effort-Shape theory (Laban, 1950), that consisted of velocity/acceleration (light-strong), directness (indirect-direct), impulsiveness (sustained-sudden) and expansion (constrained-flexible; see also Van Dyck et al., 2014). This online questionnaire was advertised through email and social media to make it as widely accessible as possible.

Participants

Thirty-seven participants completed the recognition online questionnaire (27 identified as female and 10 as male). All participants were aged between 20-25 years and were either studying for a degree or had completed an undergraduate degree or above. Fifteen of the participants studied music and had completed at least an undergraduate degree. Just four participants reported that they had received a high level of dance training.

Experimental Design

The emotion recognition experiment was designed with the within-subject independent variables condition (with two levels; happy and sad) and dancer (Dancer 1 to 4) and the dependent variables: happiness recognition intensity, sadness recognition intensity, and kinematic features (based on individual ratings of each feature taken from the Laban Effort-Shape theory; velocity (light-strong), directness (indirect-direct) impulsiveness (sustained-sudden) and expansion (constrained-flexible).

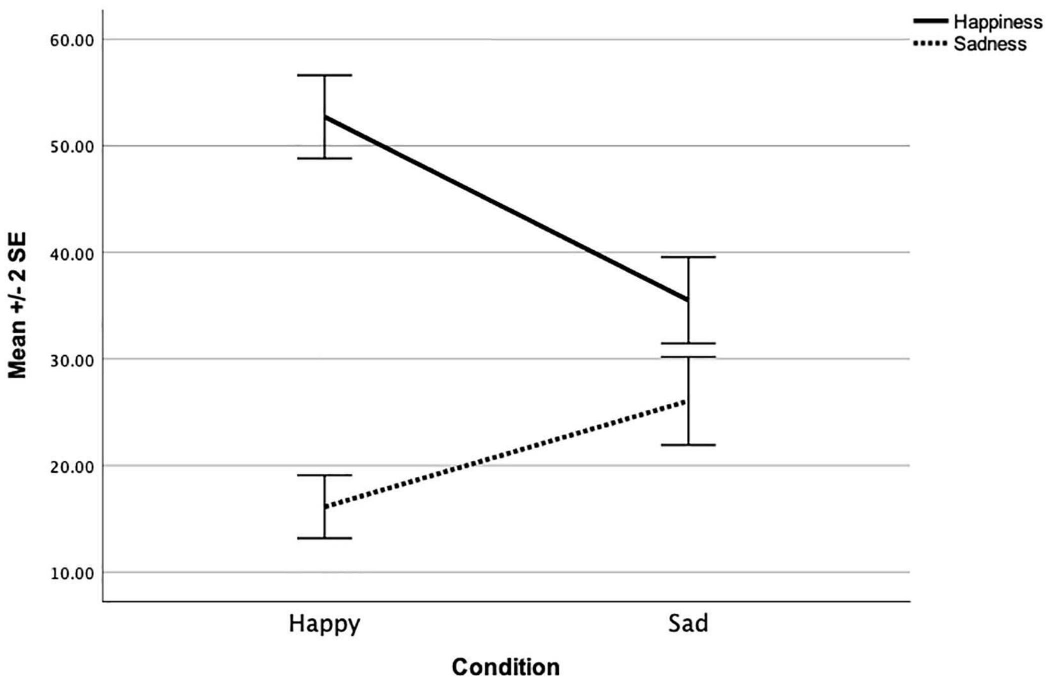
Results

Impact of Emotion-Induction Condition on Emotion Recognition

First, we investigated whether recordings of happy and sad emotion conditions evoke congruent emotion recognition ratings. Figure 2 shows the happy condition received higher ratings of happiness than sadness. However, the sad condition did not elicit higher ratings of sadness than happiness ratings. Mean differences were assessed through a repeated measures ANOVA (Table 1). There was a significant main effect of condi-

Figure 2

The Mean Intensity Ratings of Emotion Recognition in Each Condition for Dancers Overall



tion, dancer and type of emotion rating on the dependent variable. The interaction between condition and dancer showed no significant difference, while the interaction between dancer and type of emotion ratings was significant. Evaluating the interactions between independent variables further revealed an effect of interaction between condition and type of emotion rating, with a large effect size, which indicates that recognition of happiness and sadness in the happy condition was significantly different from the sad condition.

Table 1

Repeated-Measures ANOVA of Emotion Recognition Ratings

Source	*df*1	*df*2	*F*	*p*	η_p^2
Condition	1	36	10.391	.003**	.224
Dancer	2.452[a]	88.272[a]	5.086	.005**	.124
Type of Emotion Rating	1	36	95.324	< .001***	.726
Condition x Dancer	3	108	1.285	.283	.034
Condition x Type of Emotion Rating	1	36	75.656	< .001***	.678
Dancer x Type of Emotion Rating	3	108	12.096	< .001***	.251
Condition x Dancer x Type of Emotion Rating	3	108	6.409	< .001***	.151

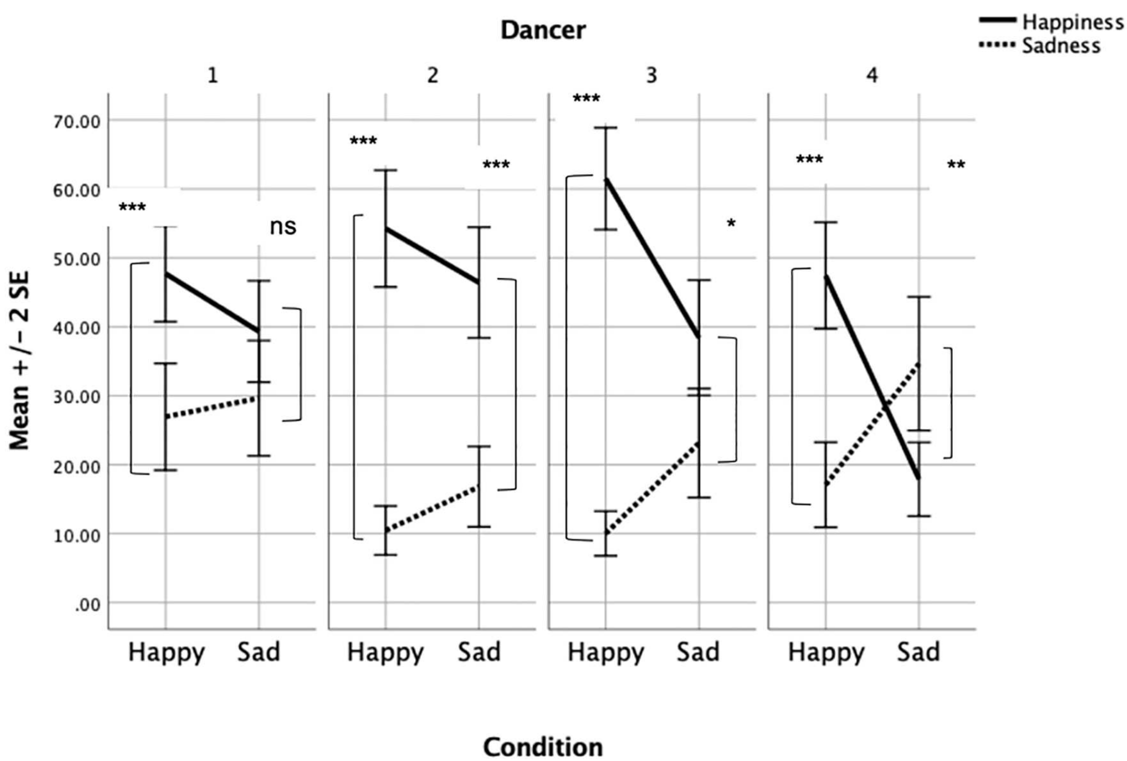
[a]Greenhouse-Geisser correction of *df.*

**p < .01. ***p < .001.

Observing the results separately for the different dancers, the graphs in Figure 3 illustrates a pattern in Dancer 4 that was expected. Here, like in the other dancers, the happy condition elicited more happiness than sadness. However, the sad condition elicited higher intensity ratings of sadness than that of happiness ratings (not seen in other dancers). This is also supported by a significant interaction between condition, dancer and type of emotion in Table 2, which shows that different dancers have different interactions of condition and emotion. Dancer 1, 2, and 3's movement cues after the sad condition may have been less clear to those rating the emotions. In addition, a paired t-test compared the emotion ratings within each condition confirming that happiness ratings in the happy condition are significantly higher than sadness ratings. However, for the sad condition, sadness was rated significantly higher than happiness ratings only in Dancer 4, and happiness was rated significantly higher than sadness for Dancer 2 and 3. For Dancer 1, there was no significant difference between happiness and sadness ratings in the sad condition.

Figure 3

Mean Ratings of Happiness and Sadness Emotion Recognition Over Two Conditions



Note. Additional paired *t*-test comparing the mean emotion ratings in each condition.

*p < .05. **p < .01. ***p< .001.

Impact of Emotion-Induction Condition on Kinematic Features

Following this, we investigated which kinematic features are perceived in video recordings of happy and sad emotion-induction conditions. Figure 4 displays comparisons between perceived kinematic features over both conditions. Assessing the graph in Figure 4, the progression from Dancer 1 to Dancer 4 declines showing a general trend across the four kinematic features.

Table 2

Repeated Measures ANOVA of Kinematic Feature Rating

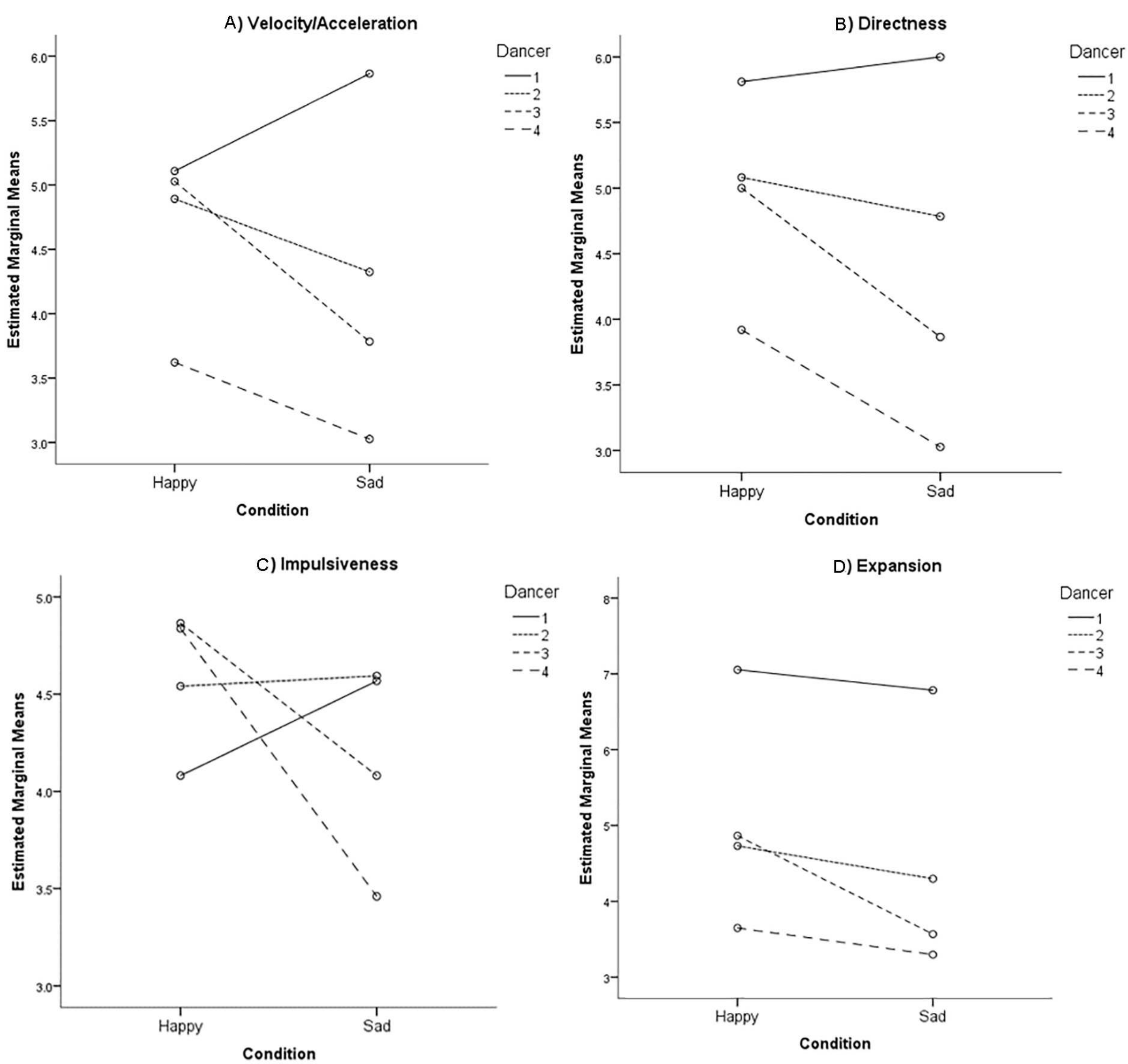
Source	*df*1	*df*2	*F*	*p*	η_p^2
Condition	1	304.775	8.217	.007**	.186
Dancer	2.476[a]	1381.975	16.654	< .001***	.316
Type of kinematic feature ratings	3	609.029	1.877	.138	.050
Condition x Dancer	3	707.637	4.255	.007**	.106
Condition x Type of kinematic feature ratings	3	259.961	.252	.860	.007
Dancer x Type of kinematic feature ratings	5.307[a]	1395.802	6.842	< .001***	.160
Condition x Dancer x Type of kinematic feature ratings	6.631[a]	701.410	1.370	.222	.037

[a]Greenhouse-Geisser correction of *df*.

***p* < .01. ****p* < .001.

Figure 4

Mean Ratings of Four Dancer's Perceived Kinematic Features (A-D) Separated by Two Conditions



The graph suggests that Dancer 1 expresses emotion through direct, strong, impulsive and flexible movements, whilst Dancer 4 shows the opposite; indirect, light, sustained and constrained movements. These results propose that Dancer 1 showed more kinematic features that equate to emotions of happiness and Dancer 4 displayed more kinematic features associated with sadness.

These observations are supported through a repeated measures ANOVA (Table 2). There is a significant difference in the perceived overall intensity of kinematic features between dancers, with a relatively large effect size, but there is no significant difference for the overall of intensity of the different kinematic features. Furthermore, there is a significant main effect of condition. The interaction between condition and dancer, irrespective of type of kinematic feature ratings, is also significant. These results indicate that overall intensity of kinematic features is different between dancers between the two conditions. Further, also condition and type of kinematic feature ratings show a significant interaction. The interactions between condition and type of kinematic feature ratings, and condition, dancer and type of kinematic feature ratings are not significant.

We subsequently analysed kinematic features separately, which might help to explain differences in emotion recognition between Dancers 1 to 3 on the one side and Dancer 4.

Velocity/Acceleration

The first kinematic feature's graph in Figure 4 (A) illustrates that all dancers but Dancer 1 were rated to have stronger movements in the happy condition compared to the sad condition. In fact, Dancer 1 displays rather an increase of stronger movement from the happy condition to the sad condition. A repeated measures ANOVA concluded that there was no general effect of condition across all dancers, $F(1, 36) = 2.429$, $p = .128$. However, the interaction between condition and dancer was significant, $F(3, 108) = 4.223$, $p = .007$, implying that the dancers individually showed a significant difference in comparison to each other between the two conditions. Further paired *t*-tests indicate that only Dancer 3 displayed significant difference between conditions (Table 3).

Table 3

Paired t-Test Comparing the Velocity/Acceleration Mean Ratings of Happy and Sad Conditions for Each Dancer

Dancer	Mean diff.	*SD*	*t*	*df*	*p*
Dancer 1	-.757	2.948	-1.562	36	.127
Dancer 2	.568	3.078	1.122	36	.269
Dancer 3	1.243	2.465	3.067	36	.004*
Dancer 4	.595	2.153	1.680	36	.102

*$p < .0125$ (Bonferroni-Corrected alpha level for 4 comparisons).

Directness

The graph shown in Figure 4 (B) suggests that most dancers decreased in the directness of their movements from the happy condition to the sad condition. This observation is supported through a significant main effect of the repeated factor condition, $F(1, 36) = 5.815$, $p = .021$. The interaction between condition and dancer, however, showed a non-significant trend, $F(3, 108) = 6.589$, $p = .067$, indicating that only Dancer 3, was perceived as significantly decreasing their directness in the sad condition compared to the happy condition, which is supported through a post hoc test (see Table 4).

Table 4

Paired t-Test Comparing the Directness Mean Ratings of Happy and Sad Conditions for Each Dancer

Dancer	Mean diff.	*SD*	*t*	*df*	*p*
Dancer 1	-.189	2.717	-.424	36	.674
Dancer 2	.297	2.259	.800	36	.429
Dancer 3	1.135	2.043	3.379	36	.002*
Dancer 4	.892	2.590	2.094	36	.043

*$p < .0125$ (Bonferroni-Corrected alpha level for 4 comparisons).

Impulsiveness

Observing the graph for impulsiveness over the two conditions in Figure 4 (C), Dancers 3 and 4 decrease for sadness compared to happiness. A repeated measures ANOVA reveals that there is a significant interaction between dancers and condition, $F(3, 108) = 3.610$, $p = .016$. Performing a paired t-test for each dancer shows that only the difference between conditions is significant in Dancer 4 (Table 5). This supports the previous results that Dancer 4 was the only dancer presenting clear opposing cues between the happy condition and sad condition. Because their movements were much less impulsive in the sad condition than any other dancer, the dancer was presumably rated to express more sadness than happiness in the sad condition.

Table 5

Paired t-Test Comparing the Impulsiveness Mean Ratings of Happy and Sad Conditions for Each Dancer

Dancer	Mean diff.	*SD*	*t*	*df*	*p*
Dancer 1	-.486	2.642	-1.120	36	.270
Dancer 2	-.054	2.321	-.142	36	.888
Dancer 3	.784	2.573	1.853	36	.072
Dancer 4	1.378	3.112	2.694	36	.011*

*$p < .0125$ (Bonferroni-Corrected alpha level for 4 comparisons).

Expansion

The perceived difference in expansion (from flexible to constrained) between conditions appears to be small (Figure 4 [D]), but significant across dancers, $F(1, 36) = 7.765$, $p = .008$. However, the *t*-tests reveal that this difference might have been strongly driven by Dancer 3, repeating similar results to velocity/acceleration and directness. Dancer 3 is the only dancer to reveal a significant difference between conditions (Table 6).

Table 6

Paired t-Test Comparing the Expansion Mean Ratings of Happy and Sad Conditions for Each Dancer

Dancer	Mean diff.	*SD*	*t*	*df*	*p*
Dancer 1	.270	2.219	.741	36	.464
Dancer 2	.432	2.873	.916	36	.366
Dancer 3	1.297	2.747	2.872	36	.007*
Dancer 4	.351	2.831	.755	36	.455

*$p < .0125$ (Bonferroni-Corrected alpha level for 4 comparisons).

Discussion

The purpose of this study was to replicate Van Dyck's et al. (2014) finding that free dance movements communicate induced emotions of dancers. Employing an advanced open response format, we were also able to test for differences between recognition of happiness and sadness within two separate emotion-induced conditions. Additionally, we studied the recognition of kinematic features within each condition and examined the differences between each dancer.

We first conducted a pre-study in order to create video recordings of dancers who underwent an induction paradigm of happiness (in one condition) and sadness (in the other condition) prior to dancing. Self-report emotion ratings indicated that here, for Dancers 1, 2, and 3 experienced happiness increased after the happiness induction condition, and experienced sadness increased after the sadness induction condition (similar to findings in Van Dyck et al., 2013). However, Dancer 4 only showed this pattern in the happy condition, but not in the sad condition. Generally, there appears to be a happiness rating bias in these results: happiness increased stronger in the happy condition than sadness increased in the sad condition. Furthermore, in both conditions, happiness is generally reported higher than sadness. This bias could potentially be explained in two different ways: First, we believe that the social setting of the pre-study has created a positivity bias in participants. Each participant had a friendly relationship with the experimenter, and conversation was difficult to avoid when directing the participant to the room. It may have been more beneficial to the experiment to have controlled interaction with limited conversation and either inform participants of this beforehand and/or used participants less familiar with the experimenter. Additionally, it might have been more socially desired to report positive feelings than negative here (Van de Mortel, 2008). Furthermore, the effect of the sadness induction might have been less effective than the happiness induction. Listening to sad music has been shown to induce also positive emotions (Kawakami et al., 2013; Kreutz et al., 2008; Vuoskoski et al., 2012).

Emotion Recognition Ratings

We subsequently tested, which emotions participants recognised in silent video recording excerpts of those dance sessions presented to them an online experiment. We could confirm our first hypothesis: Video recordings from the happy conditions were rated significantly higher in happiness than sadness. This indicates that the induction of happiness in dancers leads to more dance movements experienced as happy when listening to neutral music. However, we could not confirm our second hypothesis for recordings from all four dancers: Recordings of the sadness-induction condition from Dancers 2 and 3 were also perceived as more happy than sad. This could imply that the motion cues in this condition were less clear. These observations could be explained by the fact that in dancers the sadness induction condition was not as effective as the happiness induction condition. Accordingly, only the happy condition led to the expected emotion recognition behaviour in online participants.

However, Dancer 4 did exhibit the expected cross-pattern eliciting higher intensity ratings of sadness than happiness in the sad condition (corroborating Hypothesis 2). This indicates that the induction of sadness only had an influence of dance movements in this dancer, but not on the others. Van Dyck's et al. (2014) results show that female dancers' emotions were more likely to be identifiable than male dancers' emotions and it was concluded that females might be more likely to express emotions corporeally than males. This could explain why Dancer 4 (a female) displayed clearer emotion in their dance movement. However, our current study had a small sample size and therefore this conclusion has to remain speculative and would require further research with larger samples.

Dancer 4 was, at the same time, the only dancer who did not show an increase in sadness ratings after the sadness induction compared to the other dancers. Accordingly, it appears as if sadness was expressed in this dancer's body movements in the sad condition, but not felt by the dancer. This discrepancy between embodied expression through movement and emotional self-report could be explained by a lack of conscious self-awareness of the emotional state of Dancer 4 (independent of their gender). While their movement was reflecting an in emotional state that corresponds to the condition, their conscious experience did not. This supports the idea that an embodied approach to music cognition might be able to surpass the limitations of emotional self-report (Leman, 2007). However, this conclusion remains an assumption and would need to be explored further in future research before it could be proved as a valid explanation.

Considered together, these emotion recognition results replicate and also expand the findings from Van Dyck et al. (2014). Like in that study, observers in our study were able to recognise which emotion induction condition dancers were in. However, we also showed that there was an advantage of recognising happy emotions in the happy condition, an observation that was missing from Van Dyck et al.'s (2014) study, as these authors did not report results separately for happiness and sadness.

Kinematic Feature Ratings

Differing to findings reported in Van Dyck's et al. (2014) experiment, who found no significant differences between happy and sad dances for kinematic features, the analysis of the recognition of emotionally expressive kinematic features generally indicated that we could confirm our third hypothesis. In the happy condition, kinematic features were perceived as stronger, more direct, more sudden and flexible than the sad condition features. Accordingly, those results replicate the findings reported by Van Dyck et al. (2013) in their emotion induction experiment, who analysed kinematic features computed based on motion capture data rather than observer ratings.

However, there were differences between dancers and how these conditions influenced the way their movements were perceived. While for Dancer 1 the perception of kinematic features was not following this general effect of condition, for the other three dancers it was observed. In particular, Dancer 4's movements were significantly perceived as less direct and sudden in the sad condition compared to the happy condition (replicating also Brownlow's et al.,1997 study). This indicates that this difference in suddenness might be the underlying explanation to why only Dancer 4's video recordings from the sad condition were perceived as more sad and less happy (compared to the other three dancers). For this dancer, directness showed a large decrease from happy condition to sad condition, suggesting smoother movements in the sad condition (Camurri et al., 2003; Van Dyck et al., 2013).

Dancer 1 was the only dancer who had received extensive dance training. They showed interesting patterns of ratings opposing Dancer 4's results. Bodily expression of Dancer 1 showed generally stronger, more impulsive (only sad condition), expansion and direct movements which corresponds accordingly to the previous literature on happiness movement characteristics (Brownlow et al., 1997; Camurri et al., 2003; De Meijer, 1989; Van Dyck et al., 2013, 2014). Dancer 1 displayed more confidence and control over their patterns of movement which, due to their training, may have been perceived as more impressive than the other dancers. This may have elicited a more positive response from observers (Christensen et al., 2016; Cross et al., 2011), thus rating kinematic features associated with happiness. These observations and their extended dance training may suggest the dancer made conscious choreographic and expressive decisions to make their movement congruent with the music, even when dancing to an emotionally neutral piece of music.

Limitations and Outlook

Reviewing the methodology and findings of this study, it becomes evident that minor changes to the pre-study could have increased the internal validity of the subsequent perception experiment. Firstly, clothing of each dancer was not consistent in both conditions creating an additional potentially confounding variable. Subsequent research should therefore ask participants to wear the same clothes in both conditions (and ideally also between different dancers). The purpose of the point-light display method (Atkinson et al., 2004; Ross et al., 2012) was to evade this problem; however, it may still limit the observation of the entire body, as only a subsection of moving parts of the body are visualised. As Van Dyck's et al. (2014) report from their eye-tracking recordings, observers do not necessarily focus on head, hands and hips but rather on the entire body, which point-light display restricts. Although research shows that humans are able to recognise the structure of the body from point-light display and depth in motion (Johansson, 1973), this was largely tested on observation of common, pendular motion (e.g., walking). In the frontal view and arbitrary motion of the dancers, as in this current study, it may be harder to distinguish movement cues. Emotional shifts due to the time of day might affect overall mood (Hill & Hill, 1991; Thayer et al., 1994). In this pre-study, being able to schedule dance sessions according to participants' availability was necessary, resulting in different session times for different participants and conditions. However, the internal validity of this experiment could have been further increased by keeping the time of day constant between both conditions and all four participants.

Within the dance movement pre-study, dancers might unintentionally have been affected by experimenter-participant conversations that could explain the observed bias towards happiness in self-report of emotion. A stricter experimental procedure that excluded any unrequired communication would reduce risk of bias influences. Also, a different emotion-induction paradigm might have increased the effect of the sadness induction condition. Here, participants could have been asked to bring their most favourite sad piece of music, as previous research suggests listening to a piece of familiar music, that participant selected music is more emotionally effective than experimenter selected (Liljeström et al., 2013; Weth et al., 2015). On the other hand, this may have given away the purpose of the study. Dancer gender creates another participant variable that may have affected overall results. Although genders were of equal number, depersonalised avatars could have avoided this variable.

Conclusion

Although this study presented several limitations in its methodological approach, it was able to successfully replicate and expand on the work of Van Dyck et al. (2014) by using a different experimental paradigm when testing recognition of emotion in free dance movement. Our study therefore contributed to the investigation of dance as a mediator for embodied emotional expression. In summary, the overall results of emotion recognition and kinematic feature rating corroborated all three hypotheses presented in this study. Emotion recognition ratings reveal that dancer's movements were recognised as more happy than sad in the happy condition but only for one of the dancers as more sad than happy in the sad condition. Generally, there was a bias towards experiencing happiness overall in both, the pre-study and the perception experiment. Velocity/acceleration, directness, impulsiveness and expansion were rated higher for the happy conditions and lower for sad conditions overall, rejecting the third hypothesis.

Individually, dancers revealed interesting results beyond the investigation of the hypotheses. Dancer 1's kinematic features, mostly associated with happiness, could be explained by their training in dance improvisation and expressing emotion through dance. Awareness of expressing emotion through dance may have affected their ability to express legitimate felt emotion. Dancer 4's recognition data showed results fitting with our hypotheses. However, this dancer's self-reported felt emotions did not mirror observer's recognition of expressed sadness-related movements in the sad condition a finding which, requires further experimentation with a larger population.

The results of the study are an advocate for future research into recognition of emotions from dance movement. They suggest that emotions were communicated between dancer and observer; however, not entirely as predicted. Changes in the design of subsequent studies may explain how induced emotions were expressed but not felt and form an outcome containing additional valid contributions to research in its field.

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Competing Interests

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Ethics Approval

The present study was conducted in accordance with ethical principles and standards. It was reviewed and approved by the University of York's Arts and Humanities Ethics Committee.

Data Availability

The research data for this article are available upon request through the corresponding author.

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Appendices

Appendix A

Guided Imagery Vignettes Used in Pre-Study

The following 16 vignettes were used for the emotion induction questionnaire to attempt to evoke feelings of the two emotions happiness and sadness in participants:

Happiness:

1. You just got a new job.
2. You take a trip to the Great Barrier Reef. It is a cloudless, warm and sunny afternoon. You and your friend’s snorkel in the crystal-clear water.
3. You are tucked up in bed after an exhausting day. The day you had was extremely productive and you lay there knowing you are on top of everything.
4. You spend a night out with friends surrounded by good music, dancing and plenty of laughter.
5. You spend a day up in the mountains; the air is clear and sharp, the day is sunny, and you take a swim in a beautiful lake.
6. Your career takes a positive progression. You are sharing this news with your family and/or friends.
7. You have come home to a birthday surprise from a loved one.
8. Your partner takes you to your favourite place, with your favourite food and music. You sit there with the knowledge you are safe and with the right person.

Sadness:

9. A loved one passed away. You accept that what has been lost cannot be restored.
10. You find out a close friend has become severely ill.
11. You find out a family member has been in a car accident.
12. You are watching the news and find out several children had been held captive and abused just minutes from your home.
13. You pass a demonstration commemorating the victims of Syria. You think about bombs destroying your hometown.
14. A pet you were really fond of has died.
15. You are walking down the street and find a pet run over. A lonely old man comes out of his house crying after being told his pet had died.
16. Your closest friend of 10 years has stopped speaking to you and you don't know why.

Appendix B

Emotions Rated in Pre-study

The following 18 emotions were used in an attempt to disguise the purpose of the study when the four participants rated their felt emotion:

1. Sad
2. Blue

3. Downhearted
4. Happy
5. Joyful
6. Cheerful
7. Disgusted
8. Fearful
9. Surprised
10. Love
11. Anger
12. Content
13. Peaceful
14. Anxious
15. Hatred
16. Excited
17. Despair
18. Grief

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