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Captured by motion: Dance, action understanding, and social cognition

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ABSTRACT

In this review article, we summarize the main findings from empirical studies that used dance-related forms of rhythmical full body movement as a research tool for investigating action understanding and social cognition. This work has proven to be informative about behavioral and brain mechanisms that mediate links between perceptual and motor processes invoked during the observation and execution of spatially–temporally coordinated action and interpersonal interaction. The review focuses specifically on processes related to (a) motor experience and expertise, (b) learning and memory, (c) action, intention, and emotion understanding, and (d) audio-visual synchrony and timing. Consideration is given to the relationship between research on dance and more general embodied cognition accounts of action understanding and social cognition. Finally, open questions and issues concerning experimental design are discussed with a view to stimulating future research on social-cognitive aspects of dance.

1. Introduction

The rhythmical patterning of body movements in dance is a common practice that arises under diverse social circumstances across human cultures worldwide. Indeed, dance is a prime means of human expression that may have originated in rudimentary form as early as 1.8 million years ago, when the bipedal anatomy of Homo ergaster enabled full body movements that enhanced the capacity for gestural communication and body language (Mithen, 2005). Dance therefore has the potential to be not only beautiful in the esthetic sense, but also bountiful in what it reveals about cognition, action, and human interaction. Despite this potential, dance has only recently begun to be featured in research investigating the behavioral and brain bases of human social communication (but see Goodchilds, Roby, & Ise, 1969; Gruen, 1955; Maas & Johansson, 1971a, 1971b).

In this article, we review empirical studies that used dance as a research tool for action understanding and social cognition, and discuss their findings and implications for these fields. More specifically, this review covers studies that employed various forms of dance and rhythmical full body movements in order to investigate perception–action links. Our focus is on perceptual, cognitive, and motor processes manifested while observing and performing dance rather than on aspects of motor control related to biomechanics or rehabilitation (see Rosenbaum, 2010, for a general overview of this field). Our review thus complements previous reviews of cognitive and neuroscientific approaches to dance (Bläsing, Puttke, & Schack, 2010; Brown & Parsons, 2008), the neuroaesthetics of dance (Cross & Ticini, 2011), and psychological approaches to contemporary dance and choreography (Stevens & McKechnie, 2005). Despite the recentness of these publications, the field is growing rapidly and numerous studies have appeared that are not included in previous reviews. This increasing number of empirical studies, which signals augmented interest in the use of dance as a means of exploring the perceptual, motor, and social capacities of the human body, highlights the need for a compendium of published research to provide a platform on which further developments can be grounded.

The following review of studies of dance perception and performance includes sections on (a) motor experience/expertise, (b) learning and memory, (c) action, intention, and emotion understanding, and (d) audio-visual synchrony and timing. Finally, in the concluding remarks, we examine the reported findings in relation to embodied cognition accounts of action understanding and social cognition, as well as issues concerning experimental design.

2. Dance as a research tool for perception and action: literature review

Research in past decades has identified tight relationships between motor and perceptual processes that support close links between action execution and action observation. Much of this work has been guided by the ‘common-coding’ principle, which holds that perception and action are represented in a common format and thus share resources in functional brain architecture (Hommel, Müsseler, Aschersleben, & Prinz, 2001; Prinz, 1990). Perception–action links have been explored at the level of both behavior and

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the brain by applying a wide variety of methodological techniques, ranging from psychophysical experiments and motion capture recordings to brain imaging and single cell recording. The latter neuroscientific techniques have revealed that similar brain areas are activated when perceiving an action – via visual, auditory, or multiple channels – and when executing the same action. These areas, which include the premotor cortex, the supplementary motor area, the primary somatosensory cortex, and the inferior parietal cortex, have collectively been dubbed the 'mirror system' (Rizzolatti & Craighero, 2004). More recently, additional networks related to social cognition and/or top-down processing (i.e., inferential and theory-of-mind processes) have been identified (Grafton, 2009). A heuristic framework incorporating the common coding principle, the mirror system, and social-cognitive networks will be of assistance in describing and discussing the various experimental approaches that have been employed to investigate the processes and neural substrates involved in cognitive, emotional, and social aspects of dance.

2.1. Motor experience and expertise

Dance often requires highly refined motor skills and competency, as well as augmented knowledge of how one's own body moves. As such, it lends itself well to the investigation of motor performance and expertise. Calvo-Merino, Glaser, Grèzes, Passingham, and Haggard (2005) capitalized on this by examining whether specific brain areas become active preferentially when people observe dance movements that they are experts in. To this end, functional Magnetic Resonance Imaging (fMRI) was used to compare activation patterns associated with changes in cerebral blood flow in ballet and capoeira[1] dancers as they watched video clips of either ballet or capoeira movements. The authors found increased activation of areas associated with the mirror system—including the premotor and parietal cortices, and the superior temporal sulcus—when individuals in each group observed dance movements with which they had motor expertise. It was concluded that a person's action-observation system is tuned to his or her individual motor repertoire.

A subsequent fMRI study (Calvo-Merino, Grezes, Glaser, Passingham, & Haggard, 2006) found further support for this conclusion in the comparison of brain activations of male and female ballet dancers who watched video clips of gender-specific movements performed by either male or female dancers. The results showed increased activity in premotor, parietal, and cerebellar cortices when men observed male-specific and women observed female-specific movements. Dance expertise has also been found to be associated with stronger ventral premotor cortex activation when viewing familiar ballroom dance movements, whereas internal viewpoint observation (vs. external viewpoint) activated more the dorsal premotor cortex (Pilgramm et al., 2010). The increased activation of ventral premotor cortex in experts might therefore reflect their ability to match visuospatial information onto their own motor representations, while the dorsal premotor cortex activation may be related to watching actions from a person's own perspective.

In another study (Orgs, Dombrowski, Heil, & Jansen-Osmann, 2008), electrical signals reflecting neural activity were recorded from the scalp using electroencephalography (EEG) as professional dancers and non-dancers observed video displays of contemporary dance and everyday movements. Dance expertise was found to modulate event-related desynchronization in alpha and lower beta frequency bands in the EEG signal as a function of movement type. Specifically, the power of the signal in the 7.5–25 Hz range was reduced in dancers when they watched dance movements, suggesting that these rhythmic oscillations in brain activity may be related to observation-action matching functions carried out by the mirror system.

To investigate the influence of the creative demands of dance on brain functioning, Fink, Graif, and Neubauer (2009) conducted an EEG study in which expert and novice dancers were required to imagine that they were performing an improvised dance or a waltz. It was hypothesized that EEG alpha activity, which typically increases as a function of the creative demands of a task, should be relatively high when imagining a novel improvised dance in comparison to a more stereotyped waltz. The results supported this hypothesis, indicating that tasks that allow more free-associative thinking are accompanied by alpha activity that is more pronounced in frontal, frontotemporal, and centrotemporal brain regions compared to activity during tasks involving lower creative demands. Professional dancers also showed generally stronger alpha activity than novices.

Intensive dance training has effectively been employed as a model for investigating brain plasticity. One study has revealed decreased gray and white matter volume in brain areas associated with motor functions in professional ballet dancers relative to non-dancers (Haenggi, Koeneke, Bezzola, & Jäncke, 2010). These differences in brain structure complement findings that expertise in a particular domain is often associated with a reduction of neural activity in brain areas underpinning the control of the given skill (Haslinger et al., 2004).

At a behavioral level, it has been shown that expertise in ballet (in terms of professional experience and/or gender) is associated with higher perceptual sensitivity to subtle differences in movement kinematics when observing point-light displays of dancers (Calvo-Merino, Ehrenberg, Leung, & Haggard, 2010). Similarly, the role of motor experience is highlighted in self-recognition studies that show higher sensitivity for one's own than others' movements when observing brief episodes of dance performances in various musical styles (e.g., pop, jazz, folk) (Loula, Prasad, Harber, & Shiffrar, 2005; Sevdalis & Keller, 2009, 2010, 2011). Furthermore, studies of eye movements have revealed shorter fixation times and faster saccades in experts than novices when viewing a contemporary dance performance, suggesting that expertise may facilitate the anticipation of body movements (Stevens et al., 2010).

2.2. Learning and memory

Extensive training is necessary for achieving the high motor competency required to control the spatiotemporal unfolding of one's own body movements in relation to music and to other individuals during dance. Studies of the process of learning to dance has led to insights into how such skills are acquired, and the perceptual and motor mechanisms that underlie them. In a seminal study, Cross, Hamilton, and Grafton (2006) had expert dancers learn novel, complex modern dance sequences over a 5-week period. Brain activity was recorded using fMRI each week while the dancers observed the sequences performed by a model dancer. The results showed that brain activations in premotor and parietal areas were enhanced by the ability to perform the observed movements (i.e., if the observer had previously rehearsed the sequence, compared to sequences that had not been rehearsed), suggesting that experience dependent action simulation accompanied the perception of the dance movements.

In another study (Cross, Kraemer, et al., 2009b), novice dancers were trained on complex techno dance sequences over 5 days either with or without concurrent physical practice; i.e., some sequences were learnt via active rehearsal and others by passive observation. The comparison of brain activity when viewing the

[1] Capoeira is a Brazilian art form that combines dance and martial arts maneuvers.

two types of sequence indicated that observational (passive) and physical (active) learning engaged common neural substrates in premotor and parietal regions, suggesting that a similar action-observation network was recruited independently of the type of learning. However, experience is only one of several factors affecting action simulation. Other parts of the action-observation network located in the superior and posterior temporal cortex respond preferentially when observing actions performed by other humans (e.g., a model dancer vs. arrows serving as cues to dance steps accompanied by techno music) regardless of whether the action is familiar (Cross, Hamilton, et al., 2009a).

Opacic, Stevens, and Tillmann (2009) proposed that dance movements are governed by a non-verbal 'grammar', or 'movement vocabulary', that introduces regularities into the structure of movement sequences. These authors found that novice observers can implicitly learn the grammar underlying these regularities through mere exposure. Novices and experts may differ, nevertheless, in the way they represent dance movements in long-term memory. There is evidence that expert dancers form hierarchical mental representations based on relations between specific phases of the dance movements (e.g., the different body postures that are traversed when performing a Pirouette) while novices show less evidence for such structural organization (Bläsing, Tenenbaum, & Schack, 2009; Smyth & Pendleton, 1994; Starkes, Caicco, Boutilier, & Sevsek, 1990; Starkes, Deakin, Lindley, & Crisp, 1987).

In addition, memory for observed dance movements may be enhanced when the participant has previously performed the movements (e.g., in ballet or modern dance) relative to when he or she has only observed someone else perform them (Foley, Bouffard, Raag, & Disantorose, 1991). Finally, similar results were reported when novice participants had to learn ballet movements by observing a model perform them under one of three conditions: (1) by kinematic information alone (videotapes of dances), (2) by kinematic information accompanied by music, or (3) in static series of still images extracted from the original video recording. Reproduction performance was higher in fluency and quality when dynamic kinematic information was available during the learning process, even in the absence of concurrent auditory information, relative to when only static information was available (Gray, Neisser, Shapiro, & Kouns, 1991).

2.3. Action, intention, and emotion understanding

2.3.1. Body and action perception

The human body, by being the main instrument with which individuals act upon the world, provides an informative means of exploring perceptual and neural underpinnings of actions. When observing bodies in action, elements such as form and motion are crucial. A study by Urgesi, Calvo-Merino, Haggard, and Aglioti (2007) tested the hypothesis that the visual processing of human bodies involves two separate pathways, one related to local processing of body-part details and another related to whole body configural processing. Their experimental method involved applying rTMS (repetitive transcranial magnetic stimulation) to influence neuronal excitability in the ventral premotor cortex (vPMc) and extrastriate body area (EBA) of the brain of participants who viewed upright or inverted pictures of complex configurations of dance postures (e.g., representing ballet and other dance styles). As they viewed the pictures, participants were asked to perform a matching-to-sample task, i.e., to decide which figure in a pair of two postures matched a previously briefly portrayed single sample posture. The results indicated that rTMS stimulation of vPMc significantly reduced accuracy of matching judgments for upright but not inverted bodies, whereas stimulation of the EBA reduced accuracy only for inverted bodies. These results suggest that dorsal system areas such as the vPMc are involved in processing the whole body in a configural manner, while ventral system areas such as the EBA are involved in processing local features of the body, such as details of individual body parts.

The spatial–temporal features of a dancer's movements may induce esthetic experience in the observer; indeed, this is considered to be a primary function of dance in many, if not most, cultural traditions. Calvo-Merino, Jola, Glaser, and Haggard (2008) investigated the neural underpinnings of esthetic experiences associated with watching ballet and capoeira dance movements. They found that movements depicting greater displacement of the whole body in space were associated with higher liking ratings and increased activity in the right premotor cortex and in early visual cortex bilaterally. It has also been shown that rTMS over vPMc enhances sensitivity to static body postures of various dance forms (i.e., increases the degree of congruency between participants' reported esthetic preference judgment scores on a visual analogue scale and reported esthetic preference judgment scores in the rTMS test session), while rTMS over EBA reduces it (Calvo-Merino, Urgesi, Orgs, Aglioti, & Haggard, 2010). These results extend previous findings related to global and local body processing by pointing to the involvement of similar pathways in esthetic processing (cf. Urgesi et al., 2007). Nevertheless, it should be noted that esthetic judgments of body postures and movement kinematics (e.g., in classical ballet) may vary across time due to the interaction of individual and contextual factors including audience preferences and artistic traditions (Daprati, Iosa, & Haggard, 2009).

Behavioral investigations of body and action perception have profited from the use of motion-capture technology, which allows the researcher to record the movement trajectories of markers that are attached to an individual's body (e.g., Hove & Keller, 2010). Digital motion capture recordings can be used to generate point-light displays that portray the kinematics of body parts either in their natural form or under various transformations that are introduced for experimental purposes. Studies employing point-light displays have shown that observers exhibit remarkable perceptual sensitivity in discriminating the agent (e.g., self vs. other) when observing brief episodes of actions including dance. These abilities prevail over systematic variations of the complexity of body movements (e.g., dancing, walking, hand clapping) and parametric degradations of the availability of local kinematic information for different body parts (Sevdalis & Keller, 2009, 2010, 2011; see also Loula et al., 2005; Neri, Luu, & Levi, 2006).

2.3.2. Emotion perception: children and adults

The human body in motion can convey a wide range of affective information. The ability to decode emotional meaning in expressive body movement, particularly in dance, emerges early in life. By the age of 4–5 years, children are able to decode emotions (e.g., happiness, sadness), and their intensity, when observing videos of adults dancing (Boone & Cunningham, 1998; Lagerlöf & Djerf, 2009). It has also been reported that recognition performance increases with age, and by the 8th year is close to that of adults. Furthermore, by 4–5 years of age, children can accurately portray a target emotion (i.e., happiness, sadness, anger, or fear) by manipulating the movements of a toy. For example, they are able to make a teddy bear dance along with music (from classical and film genres) in a manner that is appropriate for expressing each target emotion after having observed an adult experimenter performing similar movements with the teddy bear (Boone & Cunningham, 2001).

In adult observers, expressive characteristics of dance have been investigated by a number of methods. For instance, appraisals of static pictures of body postures (e.g., representing dance forms including ballet and modern dance) using semantic differential rating scales have been employed in studying the perception of expressive qualities of dance (Van Wieringen, van der Veer, van der Meulen, & Adèr, 1982). In addition, basic emotions, such as happiness, sadness, anger, or fear, expressed in dance or other forms of whole body movement, can be communicated accurately in dynamic full and point-light displays (Camurri, Lagerlöf & Volpe, 2003; de Meijer, 1989; Dittrich, Troscianko, Lea, & Morgan, 1996; Walk & Homan, 1984). Accuracy of expression intensity discrimination in point-light displays of dancing to funk music appears robust under brief durations of stimulus presentation (e.g., 1 s) and correlates with self-reported interpersonal sensitivity indices, such as empathy (Sevdalis & Keller, 2011).

These perceptual tendencies when observing dance have also been investigated in more naturalistic settings by using continuous response format technology that allows audience judgments to be registered online as they observe dance performances. Using such methodology, Stevens, Schubert, Morris, et al. (2009a) found that audience perception of the emotions expressed in a modern dance performance (e.g., increases in the level of arousal) was congruent with the choreographer's expressive intentions and structural aspects of the performance (e.g., more acrobatic movement and louder music). Other work has shown that dance and music (e.g., classical or contemporary) have close correspondence in the sense that similar temporal organization is evident in judgments of structural and expressive parameters, such as section ends and emotions expressed, in both sources of information (Krumhansl & Schenck, 1997; Mitchell & Gallaher, 2001).

Finally, it has been demonstrated that dancing (Argentine) tango to music with a partner increases positive affect and reduces negative affect relative to when dancing alone or in silence (Quiroga Murcia, Bongard, & Kreutz, 2009). Free-form partnered dance has also been found to be more likeable than dancing alone (Sevdalis & Keller, 2011). The positive effects of dance extend beyond the realm of pleasure, however: It has recently been reported that regular ballroom dancing with a partner stems the decline of cognitive, perceptual, and motor abilities in elderly individuals (Kattenstroth, Kolankowska, Kalisch, & Dinse, 2010).

2.4. Audio-visual synchrony and timing

Dance movements are often produced in synchrony with music, and are thus experienced in audio-visual contexts. Brown, Martinez, and Parsons (2006) sought to identify brain areas involved in performing complex dance sequences to music, and to determine whether these regions overlap with those that earlier studies found to be involved in simple movements (e.g., ankle rotation) and elementary sensori-motor control (e.g., externally paced finger tapping). To this end, metabolic brain processes were recorded in amateur tango dancers as they performed bipedal dance steps on an inclined surface while lying supine inside a PET (positron emission tomography) scanner. Dance steps were paced by tango music with either a regular metric rhythm or an irregular rhythm. Control conditions included self-paced dance steps (without music), isometric leg muscle contractions (with music), passive music listening, and eyes-closed rest. Brown et al. (2006) found that dancing to metric music was associated with relatively strong activations in various cerebellar, subcortical, and cortical brain areas including the anterior vermis of the cerebellum, the right putamen, and the medial superior parietal lobule. These results support the hypothesis that dance requires the integration of information across areas involved in the entrainment of movement to music, the temporal patterning of movement in accordance with metric rhythms, and the spatial guidance of limb movements.

Behavioral studies of dance have also proven useful in investigating the internal time-keeping processes that allow humans to synchronize their actions with others while producing complex movement sequences. Stevens, Schubert, Wang, et al. (2009b), for example, used a motion capture system to record the movements of one dancer from a trio as the ensemble performed the same contemporary work twice; first without and then with accompanying music. The silent performance was found to be shorter in duration. The authors used time-series analyses to determine whether temporal scaling (uniformly faster or slower timing) and/or lapsing (omitted or inserted material) was responsible for this duration difference, and concluded that it was mainly attributable to memory lapses rather than a miscalibrated internal time-keeping mechanism. Other work with contemporary dance has revealed that a dancer's timing abilities can be susceptible to error (e.g., lengthened duration of movement production) when attentional demands are high (Minvielle-Moncla, Audiffren, Macar, & Vallet, 2008).

Finally, recent studies have investigated the impact of audiovisual presentation of dancing sequences on perceptual processing. Although dance is often accompanied by music, the auditory concomitants of dance are frequently neglected in the perceptual studies. In one exception, synchronous audiovisual information was found to reduce temporal uncertainty in perceptual judgments of biological motion displays of tap dancing. Specifically, observers were better able to detect point-light tap dancers embedded in visual or auditory noise (consisting of additional random dots and tap sounds) when dancer movements and related sounds were in synchrony than when they were out of synchrony (Arrighi, Marini, & Burr, 2009). Nevertheless, rich audiovisual contexts are not always required for accurate perceptual judgments, especially in less attentionally demanding tasks. The visual recognition of higher-level stimulus properties—such as the identity and the intended expression intensity of a human agent depicted in point-light displays—does not necessarily benefit from concurrent synchronous auditory information (e.g., accompanying music) associated with the depicted dancing action (Sevdalis & Keller, 2009, 2010, 2011). For instance, temporal information provided by concurrent auditory information may be encoded motorically, in the displayed dancers (see also Leman & Naveda, 2010). Thus, when auditory information is not directly relevant to the perceptual task, it may be assigned low weighting due to the presence of more reliable cues and more salient information in the dancers' movements (i.e., visually communicated kinematic information).

3. Concluding remarks

This article reviewed empirical studies that used dance as a research tool for exploring the behavioral and brain bases of action understanding and social cognition. Our overview of literature in the field was organized into sections on (a) motor experience and expertise, (b) learning and memory, (c) action, intention, and emotion understanding, and (d) audio-visual synchrony and timing. We conclude by briefly recapitulating the major findings, and then comment on the implications of these findings for future research.

Studies related to motor experience and expertise have consistently highlighted the importance of the observer's own action history for understanding the actions of others. Such results provide strong evidence for the tight coupling of perception and action at both behavioral and brain levels of analysis. This coupling is also evident in studies that have demonstrated that the learning of dance-related movement sequences depends on the level of motor involvement during observation, acquisition, and retention. As a non-verbal means of expression, dance has proven to be an effective medium for examining aspects of social cognition, such as visual body perception and the communication of performers' emotions and intentions, as well as esthetic qualities of movements. Finally, the use of dance for investigating the timing and dynamics of actions and interpersonal interactions complements earlier work on simple actions, and has extended it to complex settings that approximate real-life situations. Thus, the reviewed literature suggests that the implementation of dance-related movements in observation- and execution-based experimental designs can take various forms, thereby constituting a rich domain for exploring behavioral and brain functions in human action and interaction.

The fact that dance is a prime means of expression found in human cultures around the world imbues such an approach with ecological validity, increasing the likelihood that results obtained under controlled laboratory conditions generalize to non-experimental (wider) contexts and across individuals. In addition, research can benefit from employing the trained human body to gain insight into the factors and mechanisms that contribute to exceptional motor skill and expertise. Therefore, by allowing some space for experimental participants' creativity to unfold – as they move in their own idiosyncratic ways – behavioral outcomes could emerge that stem from and are applied to everyday contexts and experience.

From a theoretical point of view, such premises are compatible with recent enactive/embodied (cognition) approaches (e.g., Grafton, 2009; Schubert & Semin, 2009; Wilson, 2002) that emphasize the role of the human body in shaping behavioral and brain functions. An enduring question regarding mechanisms of action understanding and social cognition is whether simulation processes (i.e., motor resonance and its neural substrates) are especially active for actions that are embodied, that is, for actions that the individual is able to perform and/or has previous physical experience performing. In order to assess how one's own and others' actions are represented in the observer's motor system, and explore the possibility of overlapping neural resources for action observation and execution, it is crucial to discover which factors mediate the simulation process and the ways they are intertwined. Using the human body in its full motor potential (such as in dance) offers a unique possibility to uncover these features. For instance, it might be worthwhile, when investigating social interaction, to encourage participants to engage in actions and/or natural interactions that include full body movement, such as to move together; when investigating learning, to study how individuals learn to move to music. Additionally, despite the wealth of results offered in the reviewed literature, it would be advantageous to expand the perspectives of dance-related work on action understanding and social cognition. To give a concrete example, if the focus of a study was on emotion recognition performance by non-expert adults, it may be worthwhile to use similar research designs with children, experts or professional dyads; if the results were obtained by a psychophysical experiment in the laboratory, then a similar approach in an applied context might provide complementary information. The reason that justifies such plurality is that emotion recognition performance in non-expert adults may or may not be underpinned by the same neural and behavioral processes and mechanisms as those for professionals, and this can have important consequences when framing conclusions about explanatory constructs.

When formulating research hypotheses and designing experiments to probe relations between dance and brain/behavioral processes, it is important to bear in mind some general issues that derive from the work reviewed above. These issues are related to the intra-personal and inter-personal processes that are being investigated, and the factors that impact upon them. For instance, what is the activity or the process under scrutiny? Target behaviors may include performing, co-performing, and listening/observing. What is the nature of the information available during the performance or in the experiment? During performance and/or observation, how is information communicated? A variety of physical stimulus properties can be manipulated for experimental purposes, including movement features (e.g., expressive vs. inexpressive, large vs. small amplitude, belonging to a particular movement vocabulary vs. free-style), auditory information/music (e.g., fast vs. slow, positively vs. negatively valenced, congruent or incongruent with displayed movement features), and communication modalities (e.g., vision, audition). Where does the action or interaction take place? Individuals' performance can be studied in context, while performing in private or publicly, spontaneously or formally, while rehearsing/learning, and may allow cross-cultural comparisons. When do the events occur? Issues concerning timing, synchrony, and coordination may be of interest.

Similarly, who is the individual under investigation or the unit of analysis? Research may benefit by approaching a target hypothesis or empirical issue by multiple perspectives such as those by a performer, a co-performer, a spectator, a soloist vs. a dyad, or an ensemble. To what extent is the acting or observing individual sensitive to the information available? Are there any personality or individual differences present? These may include, for instance, developmental processes, gender differences, musical preferences, and musical expertise. What kinds of relations exist or may develop between participants? Interpersonal affiliation tendencies, positive affect, or leader–follower dynamics, for instance, may alter performance or occur as consequences in interactions.

These examples and questions are not intended to convey the full range of issues that can be addressed in future studies. They should, however, serve to illustrate the variety of issues that require answers. Research questions in empirical studies often span multiple conceptual levels (e.g., ranging from intra-personal, through interpersonal, to cultural), and hence demand methodological diversity when choosing what variables to manipulate and assess. An integrative approach—attempting to identify interconnections between different levels of analysis—will be useful when implementing research designs employing dance and body movement both as a tool for, and as an area of research within, the fields of action understanding and social cognition.

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