Chapter 14
Emotion and Body-Based Games: Overview and Opportunities

Nadia Bianchi-Berthouze and Katherine Isbister

Abstract In this chapter we examine research and theory concerning body movement as a means for expressing emotion, and techniques for recognizing expressions of emotion in the context of games. We discuss body movement as a means for biasing emotional experience and encouraging bonding in social interaction. Finally, we discuss gaps and opportunities for future research. Promising directions include broadening the scope of body-based games and emotion to take proprioception into account, as well as other less explored body channels such as muscle activation and action-related sound.

Introduction

The last two decades have witnessed an increased interest in studying emotion in many research fields (e.g., psychology, neuroscience, computing, engineering, design, medicine, philosophy, HCI). This growing interest in emotion is due to the recent appreciation of the close interaction between cognition and emotion and how emotion is indeed critical to many cognitive processes [1]. Among the various aspects of emotion that are being investigated, of particular interest to game researchers is the relation between emotion and the body as a channel of input and feedback [2]. This interest is driven by the fact that the last 10 years have brought robust body movement-tracking to all of the major game consoles, and have ushered in an era of increasingly sophisticated movement tracking capabilities in smartphones. This has made it possible to create and release games that take advantage of body position and movements, as core mechanics and also as feedback systems for understanding player response. There has been a proliferation of games in this space, and also of research about such games.

N. Bianchi-Berthouze (✉)
UCLIC University College London, Gower Street, London, UK
e-mail: n.berthouze@ucl.ac.uk

K. Isbister
Computational Media, University of California, Santa Cruz, CA, USA
e-mail: katherine.isbister@ucsc.edu

K. Karpouzis, G.N. Yannakakis (eds.), *Emotion in Games*,
Socio-Affective Computing 4, DOI 10.1007/978-3-319-41316-7_14

Given the strong relationship between movement and emotion, researchers have been exploring the opportunities that such games might provide. Using terms such as exergames [3] and exertion games [4], researchers have been investigating how physical activity could become more enjoyable and affordable through the use of games in either the comfort of one's home or in the outdoor environment. They have attracted a lot of interest from the research community and from the industry, and are seen as an opportunity to address health challenges (e.g., diabetes) that characterise our society. More broader terms such as body games [5] and movement-based games [6] have been subsequently introduced to consider other benefits of movement such as its general positive effect on emotional and social well-being as well as the opportunities that it offers for the design of the game itself.

For the purposes of this chapter, we use the umbrella term 'body-based games' to take a broad perspective of what the body is, how it expresses and biases our own emotions and the emotions of others, as well as how it can be tracked by sensing technology. Rather than providing a definition of what emotion is and what body-based games are, this chapter aims to provide an overview of the relationships between these two concepts. There is in fact a great deal of research that establishes a link between body positioning and motion, and emotion. And there is a body of game-based research that explores motion as a way to generate emotions in players, in games for entertainment as well as 'serious' purposes. This chapter covers both sets of terrain, building bridges between them and establishing areas for future work.

We begin by examining research and theory concerning body movement as a means for expressing emotion, and techniques for recognizing these expressions in the context of games. Then, we discuss body movement as a means for biasing emotional experience. Next, we cover body movement as a means for bonding in social interaction. Finally, we discuss gaps and opportunities for future research, given this overview. This includes broadening the scope of body-based games and emotion, to take proprioception into account, as well as other less explored body channels such as muscle activation and action-related sound, when considering design and evaluation of games.

The Body as a Means for Expressing Emotions

Theory

Even if the term emotion is commonly used both in everyday life and in research, there is still much debate and disagreement concerning what emotions are [7, 8]. In this chapter, rather than providing an overview of the different definitions of emotion and related affective processes, we focus on how these can be measured or can be regulated. An emotion, or more generally an affective state, is accompanied (or defined) by neural, physiological and behavioural changes triggered in response to the evaluation of an event. For example, research in digitally augmented physical playgrounds [92] has shown that specific physiological measurements correlate well with and allow quite reliable predictions of the player's preferences while using the playground [93]. They also showed that these characteristics differ to a certain degree from the ones triggered by exertion. Beyond physiological and neural changes, a growing accumulation of research has shown that body expressions (and not just facial expressions) are an important channel for affective communication (see [9] for a review). De Gelder [2] argues that, differently from facial expressions, body expressions tell us not only how a person feels but also how the person is ready to respond (action tendency) to an emotional event. In this chapter, we focus mainly on body movement as an affective modality since it is the one that is used to control the body-based games and that is visible to others.

Two main approaches are used to characterise emotional expressions: dimensional and discrete. Initial work by Ekman and Friesen [10] suggested that the body may be better at communicating broader dimensions of affect than discrete categories. Subsequent studies (e.g., [11–14]) on both acted and naturalistic body expressions confirmed that people do indeed used affective dimensions such as arousal, valence, potency and action tendency when describing these expressions. However, perceptual studies also showed that people do describe body expressions by using discrete emotions with level of agreements well above chance and at levels similar to the ones observed for other modalities (e.g., [15–17]). In fact, a recent study by Aviezer et al. [18] has further confirmed similar results from previous work ([9] for a review) showing that body expressions rather than facial expressions allow us to discriminate between intense positive and negative emotional states.

Various coding models have been proposed to facilitate the analysis of affective body expressions. They aim is to capture the body configuration (its form) as well as its dynamics. Neuroscience studies show that these two types of features may be partially redundant but in combination they help to recognize more complex expressions or solve inconsistencies (e.g., [19–21]). Those studies also show that form alone provides stronger cues for the emotional categorization process than dynamic cues do.

The second main distinction between body description approaches is the use of high-level versus low-level descriptors. The first, often based on the Laban approach [22], describes body expressions through coarse dimensions such as Openness, Jerkiness, Directness. The second approach instead aims at describing body expressions by providing a more precise measure of the distances between body joints and angles between body segments [16, 23]. The review by Kleinmsith et al. [9] provides a set of detailed summary tables of these approaches listing high-level and low-level features and their relationship to both discrete emotions and affective dimensions. While high level descriptors are very useful as they provide a compact description of the expression, the emergence of full-body tracking technology makes low-level descriptions a feasible and possibly richer approach to describe body expressions. A body of work relating these low-level features to emotions is indeed emerging (for an in depth discussion on this topic see also [24]. The study by Kleinsmith et al. [12] show that nuances of emotions can be explained in terms of variation of low-level postural features.

An attempt to provide a more comprehensive multilevel framework for coding is proposed by Fourati et al. [25, 26]. This framework combines both high-level and low-level description of body expressions and includes anatomical, directional and posture/movement descriptors. In this work, they investigate both the use of body tracking technology to provide continuous and rich description of the expressions, as well as qualitative gross descriptors provided by human observers. They argue that such a unified framework is crucial to facilitate the investigation of body expressions of emotion in everyday action and when studying multiple types of action at the same time. Through the use of the framework, they show the existence of a hierarchy of features important in the categorization of emotional expression in everyday action. A feature hierarchy has also been found by Kleinsmith et al. [12, 27] in prototypical body expressions of emotions.

Finally, as with other modalities, factors such as gender, culture and age among others may affect the way we use our body to express an emotion, as well as how we interpret other people's body expressions. A study by Kleinsmith et al. [15] showed that cultural differences exists in the way certain body expressions are interpreted in terms of their valence and arousal level. This is also supported by the more recent work by Volkova et al. [94] on perception of body expressions in story-telling.

Practice

These findings, together with the ready availability of body-based game controllers, have led game designers to consider the opportunities that the body channel offers to personalize the game experience for the player to heighten emotional impact. For example, games that incorporate improvisational movement into the core game mechanic allow for a broad range of emotional expressions. *Yamove*! (Fig. 14.1) is an instance of this approach [28]. Dancers can modulate the emotional tenor of their movements based on the music they are listening to, and how they are feeling (or how they want spectators to feel). *Yamove*! does not track and recognize player emotions—it simply offers a range of expressive possibilities to players. However, other research teams have built on initial work in the field of affective computing, toward building systems able to automatically discriminate between affective body expressions (e.g., early work by Camurri et al. [29] in the dance context; and Bianchi-Berthouze et al. [23] for acted postural expressions). For a more complete review see surveys on automatic perception and recognition of affective expressions [9, 30].

More recently, researchers have started to tackle the problem of recognizing naturalistic body expressions in order to create systems that can be applied to real-life situations. Table 14.1 provides a summary of the studies discussed here, as well as the datasets that were used and that are generally available to the research community upon request from the authors. A study that aims at detecting emotional states from non-acted body expressions in full-body games (Nintendo Wii sport games) is presented in [13]. The aim was to recognize four player's emotional state

Fig. 14.1 *Yamove*! [28] encourages improvisation from players, allowing for a range of emotional expression. The game's core mechanic is improvised dance. Two dance pairs compete against each other in a dance battle. Each pair makes up moves that they can do well together—scoring is based on synchrony of movement, as well as creativity and pace (Image used with permission)

and levels of affective dimensions during replay windows, i.e., when the player is observing and re-evaluating his/her performances in the game. As the context is quite static, the system was built to recognize the affective message conveyed by the configuration of static postures. Full body motion capture sensing technology was used to this purpose. The results showed correct average recognition rate just above 60 % for four affective states (concentrating, defeated, frustrated and triumphant) and 83 % for two affective dimensions (arousal and valence). The results were comparable with human observers' level of agreement reached for the discrete emotions (67 %) over the same set of stimuli and around 85 % for valence and arousal dimensions. In a subsequent study [31], they show that in these semi-static situations, the form features led to performances similar to agreements between human observers even when those were rating the animated clips rather than the apex postures. Moving to a more dynamic situation, Savva et al. [32] investigated the recognition of four emotional states while playing the game. Using dynamic body features, the system performance reached an overall accuracy of 61.1 % comparable to the observers' agreement (61.49 %). Zacharatos et al. [33, 34] repeated similar investigations using different motion capture systems in the context of Microsoft full body Kinect games. In [33], they investigated the possibility of discriminating between low arousal and high arousal states. A vision-based system rather than a mocap system was used to track and measure the body expressions of the player. Laban-informed dynamic features were used to describe the movement. The results from two studies show on average recognition performances just above 90 %. In [34], through postural features captured by the MS Kinect skeleton, they modeled

Table 14.1 Body-movement-based emotion recognition systems in game practice and related naturalistic datasets (over three pages)

ID	Dataset	Emotions	Body tracking	Body features	Target performances	System performances
Kleinsmith et al. [13]	AffectME-posture naturalistic dataset-Nintendo Sports Game	Discrete: concentrated, defeated, frustrated, triumphant	Full body motion capture (Animazoo suit)	All body joint angles at apex of expression	Human agreement: 66.7 % (discrete emotions), 85 % (arousal, valence), poor (potency, avoidance)	Discrete emotions: 63.5 %, arousal, valence: 83 %
		Dimensions: arousal, valence, potency, avoidance		Normalized to feasible movements		Machine learning: SVM, NLP
Kleinsmith et al. [31]	As above	Discrete: concentrated, defeated, frustrated, triumphant	As above	As above but on 5 frames of a 200 ms windows centred on apex	Human agreement: 66.7 % (discrete emotions), 85 % (arousal, valence), low (potency, avoidance)	Discrete emotions: 63.5 %, arousal, valence: 83 %
						Machine learning: SVM, NLP
Savva et al. [32]	Affect ME-movement naturalistic dataset: Nintendo Sports Game	High negative, happiness, concentration, low negative	Full body motion capture (Animazoo suit)	Rotation, angular velocity, angular acceleration, direction: hands, head, arms, forearms, spine. Movement amount all 17 joints	Human agreement: 61 %	Average: 61.5 %
						Machine learning: Recurrent Neural Network (RNN)
Gao et al. [90]	Touch-based game	Discrete: excited, relaxed, bored, frustrated. Arousal, valence dimensions	Iphone touch screen	Finger strokes: direction, length, pressure, velocity	Self-reported	Emotions: 77 %
						Dimensions: 88 %
						Machine learning: DA, SVM, NLP

Zacharatos et al. [33]	Microsoft kinect game	Meditation, concentration, excitement, frustration	PhaseSpace impulse X2 motion tracking system with 8 cameras	Direction, velocity, acceleration, jerk of feet and hand	Cross-validation	Binary classification: 91 %
						Four-classes: 85 %
						Machine learning: NLP
Zacharatos et al. [34]	MS kinect game playing (postures)	Concentrated, defeated/frustrated, triumphant	Kinect sensors	Joint rotations at frame level for all joints of kinect skeleton	Human agreement: 72 %	Average: 56.4
						Machine learning: NLP
Olugbade et al. [37, 38]	EmoPain dataset: 3 physical rehabilitation exercises	Healthy people, low pain, high pain	Animazoo full body suit, 4 BTS EMG probe on high and low back	Forms and rotational information: head, arms, lower legs, hips. EMG: general statistics and activation and deactivation points	Self-reported pain level	Stretching forward: 86 %
					(People with low-back chronic pain and healthy participants)	Full trunk flexion: 94 %, Sit sit-to-stand: 69 %
						Machine learning: SVM, RF
Aung et al. [35, 36]	As above but 5 physical exercises and non-instructed movements	Pain-related behaviour: guarding, hesitation, limping, bracing	Same as above	17 body joints measured by motion capture and 4 EMG probes: a large set of form and kinematic features	Human agreement varying according to exercise and pain behaviour: (ICC) 0.5–0.8	Correlations varies according to exercise type: 0.1–0.07
						Machine learning: RF
Griffin et al. [39, 40]	UCL-body laughter: people playing games while standing or sitting (multi-person)	Hilarious laughter, social laughter, awkward laughter, fake laughter, non-laughter	Animazoo suit	All 17 body joints: min, max, range of angular rotation, direction of movement of spine, energy over windows of (non) laughter	Human agreement: 0.94	Laughter types: 0.91
					(Ground truth: ranking)	(Ground truth: ranking)
						Machine learning: various regression models but best results with RF

(continued)

Table 14.1 (continued)

ID	Dataset	Emotions	Body tracking	Body features	Target performances	System performances
Niewiadomski et al. [42] extended from	Person laughing	Laughter, non-laughter, laughter intensity	Two scenarios: X-sense motion capture, MS kinect	Head speed statistics, trunk leaning and throwing (periodicity, amplitude, impulsiveness), shoulder (energy, periodicity, correlation), etc.	Human observers: 0.71	Average F1: 0.66–0.80
Mancini et al. [41]						Laughter intensity: 0.44
						Machine learning: (SVM, RF, SOM, k-NN, probabilistic models)
Fourati et al. [25, 26]	Everyday movement: sitting, walking, knocking, moving objects, lifting, throwing, etc.	Anxiety, pride, joy, sadness, shame, anger, neutral, panic-fear	X-sense motion capture	Multi-level framework kinematic and form features at both low- and high-level	Acted	Performances varies according to emotion and action: 53–92 %
						Machine learning: RF, SVM

three of the emotional states used in [13] with a performance level of 56.4 % despite the use of a simpler skeleton model. All these studies show performance well above chance levels, and in most cases well close to human agreement as it can be seen in Table 14.1.

Still in the area of exertion body technology, work by Aung et al. [35, 36] and Olugbade et al. [37, 38] investigated the possibility of detecting pain-related behaviour and fear of movement to inform the design of affective-aware technology for gamified physical rehabilitation. By using mainly gross level body features measured from data from mocap suit and EMG sensors worn by the patients, they were able to predict well above chance level the pain level (discretized into none, low, high) self-reported at the end of each physical exercise and pain behaviour (e.g., guarding) as rated by physiotherapists. Though not specifically in a computer game situation, emotions related to playful multi-person interaction are studied in Griffin et al. [39, 40]. They explored the possibility of automatically classifying laughter types from body expressions. Results show that combining form features with energy features led to recognition performances for three laughter types (hilarious, social, fake laughter) and no laughter in both standing and sit-down situations that were comparable with humans' agreement levels. By adding directional form features and kinematic features, the results were further improved. Whilst this work is based on low-level features, Mancini et al. [41] and subsequently Niewiadomski et al. [42] explored high level features of body laughter. An implementation of laughter recognition capabilities in the context of computer games with an artificial co-player is provided in Mancini et al. [43]. The avatar receives multimodal signals from the players to understand when they are laughing and when it is appropriate to laugh and how to laugh (e.g., mimicry) in response with its body [44, 45]. Other multimodal databases including full body movement in a two-person (non-computer) game scenario is reported in [91] aiming to foster research on automatic recognition of social interaction predicates. All these studies provide evidence of a clear increase in focus not only on body as an affective modality but also on the move towards real-life complex situations, a very important step toward being able to deploy such recognition capabilities in real-life applications.

The Body as a Means for Biasing Emotions

Theory

Theories of embodied cognition [46] suggest a dual role of body expressions. Body expressions not only convey to others how we feel, but also affect how we feel and related cognitive processes. As body expressions were recognized to have an important role in communicating emotions, Risking et al. [47] investigated how a person's confidence level could be manipulated by asking them to held a body position that reflected a specific emotional state: a slumped position reflecting submissiveness and an upright position reflecting confidence. These results were confirmed more recently by the work of Brinol et al. [48] showing that an enacted affective body position biased people's attitudes towards the enacted emotion.

This biasing effect has also been observed in relation to judgment of objects or events a person is asked to evaluate. Early work by Cacioppo et al. [49] observed that arm gestures performed during the evaluation of neutral objects affectively biased their appreciation. Arm gestures that are generally associated to an approach-motivational orientation lead to more positive judgement of the neutral objects than arm gestures associated with an approach-withdrawal orientation. Memory processes are also seen to be facilitated by related affective body expressions. Casasanto and Dijkstra [50] showed that moving objects with upwards facing hands facilitated the retrieval of positive emotions whereas downwards hands led to faster retrieval of negative emotions. Similarly, positively-valenced body movements were shown to lead to be more easily persuaded [51]. Recent work by Carney et al. [52] investigated the biological processes underlying these biasing mechanisms. They found that the production of hormones related to the readiness of an emotional response (e.g., attacking vs. withdrawing) was affected by the enactment of body expressions that reflected such emotional states (highly confident vs highly submissive).

The effect of body expressions on emotion can be also modified by altering the perceptions of one's body. Recent neuroscience studies on sensory feedback integration show that people continuously update the perception of their own body (e.g., [53, 54]). Building on these findings, Tajadura-Jimenez et al. ([55] showed that people's perception of the length of their body and body parts (perceiving longer arms) can be manipulated by altering the sound of one's body action with a consequent effect on people's behaviour and emotional states.

Practice

Building on this body of work, researchers in the field of body-based technology and in particular in game design have started to investigate how such biasing mechanisms could be exploited to design better player experiences. Lindley et al. [56] showed a relationship between 'naturalness' and freedom of movement and the emotional experience of a game. Their study found that an input device that encouraged more 'natural' body movements (i.e., Donkey Konga Bongos) led to an increase in emotional expressions and social interaction. These were measured both in terms of vocal and non-verbal behaviour. Similar results had been previously observed in Berthouze et al. [57] within a different playing context and using a different type of body movement controller. Both studies showed also that the use of body movement control related to the story of the games led players to freely enact other strongly emotionally valenced context-related expressions that could even distract from the main aim of the game, facilitating a broader affective experience.

Pasch et al. [58] and Nijhar et al. [59] build further on these findings showing that the emotional experience a player was looking for led to a different appropriation of the movement recognition precision offered by the game controller. For players motivated to win, the body movements that the game required were used to win the game. Instead, players playing to relax made used of increased recognition precision of the game controller to engage with their own body movement. Melzer et al. [60] and Isbister [61] developed on this further by looking at how body movements may affect the emotional component of the gaming experience. Their studies found that games that encourage body movement leads to higher levels of emotional arousal than those that use a standard controller stand standard controller. Building on this body of work and on the theory of embodied cognition, Berthouze [62] suggests a framework that extends previous engagement models presented in the game literature to include the role of proprioceptive feedback. She proposes five categories of body movements that affect the player's experience: movements necessary to play the game, movements facilitating the control of the game, movements related to the role-play the game offers, affective body expressions and social gestures.

The recent work on sensory integration and body representation update has pushed the boundaries for exergames and their use further into contexts where emotional experience is critical. Singh et al. [63] investigated the use of psychologically-informed movement sonification to change people perception of movement capabilities during chronic musculoskeletal pain physical rehabilitation. When using the proposed tracking and sonifying wearable device, people reported to feel more confident in moving, to perform better (even when this was not the case) and demonstrated higher copying capabilities, i.e., being more ready to take on more difficult challenges [64]. The effect of sound on emotion and behaviour was also demonstrated by Bresin et al. [65]. By altering the sound produced by a person's walking steps, they were able to alter the person's perception of the walking surface material (e.g., snow) and this was reflected in a congruent change in walking style and reported emotional state. In Tajadura-Jimenez et al. [66], the authors showed that through the use of special shoes (Magic Shoes – Fig. 14.2) embedded with microphones to capture and deliver back to people (via headphone) the altered sound of their footsteps, they could control people's perception of their own body e.g., (higher frequency sound made people feel thinner) and alter accordingly their walking behaviour (e.g., faster movement) and their emotional states (more positive).

The Body as a Means for Social Bonding

Theory

Incorporating social interaction into a movement-based game adds a layer of complexity to understanding the emotional impact of the game. Emotional expression

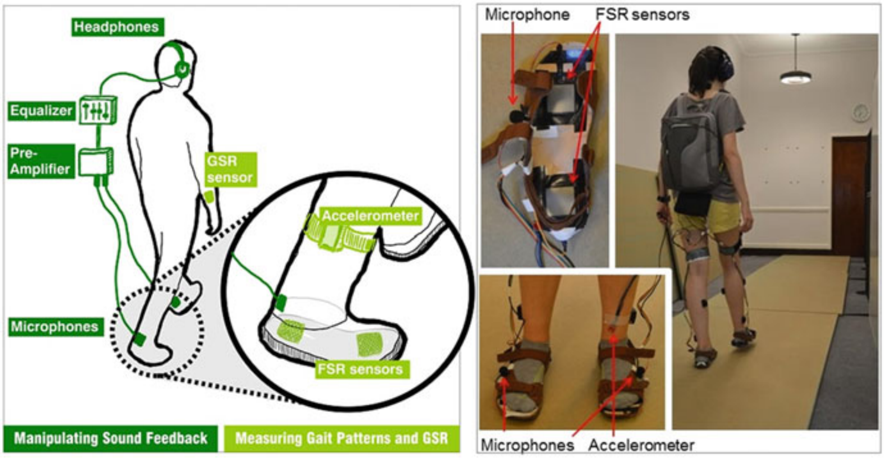

Fig. 14.2 Magic shoes: altering one's body perception through manipulation of sounds made by the sensed body actions [66] with permission of reprint

and signalling is an important aspect of human interaction; therefore in a social play context we must examine emotions as they unfold socially. We need to understand not just the individual's feelings, but also, the effect these have on fellow players and spectators, and vice versa. Researchers have demonstrated that when we observe another person enacting an emotion with the face and/or body, we experience their emotions to some degree—a phenomenon referred to as 'emotional contagion' [67]. Thus, movement mechanics in games that encourage the performance of particular emotional states can be expected to induce some emotional response not just in the player, but also in fellow players and in spectators. Researchers have also found that particular emotional effects can be evoked through encouraging or inducing movement synchrony between people [68, 69]. Specifically, inducing coordinated movement increases compassion and empathy for one another, and social connection to one another. Finally, there is literature that links the manipulation of interpersonal distance—the space between people as they interact—to emotional responses [70, 71]. Bringing people closer together than is socially appropriate in a given cultural context, for example, can lead to strong negative emotions.

Game designers and researchers have developed theory that can be useful in understanding the impact of social movement-based play on emotions, towards designing better social movement and 'exer' games. At a fundamental level, game researchers have postulated that games provide a safe 'magic circle' within which alternate social movement practices are acceptable and even desirable [72, 73]. This can allow interplay between the emotions a person would normally have about an interaction, and how they feel given that what is happening is 'only a game', opening up interesting terrain for exploring and working with emotions that might otherwise be overwhelming or unacceptable. Taking a close look at the social interaction that happens around games, researchers have separated explicitly social play from sociability that is happening in and around that play [74]. For example, I might give a fellow player a happy ‘high five’ after winning a round, and that would be sociability, whereas the game Dance Central actually uses a ‘high five’ performed between opposing players to begin a game-play round—this is ‘social play’. In either case, the movement may result in emotions, but the tenor of these emotions could differ depending upon whether the movement was spontaneous or was required in the service of gameplay.

Researchers have also pointed out that not all player movement is accurately detected by many movement-based games, so therefore much of the movement players engage in is actually ‘gestural excess’ [75] that is not analysed and made use of by the game system. Players often put more movement expressivity than is necessary into movement-based games [62]. As players’ emotions can be strongly related to the manner in which they perform the game’s movement mechanics [6, 76], cultivating this gestural excess through designing the social framing of the game can be seen as an important component of designing social movement-based games [56, 77]. Researchers have also pointed out that we must consider spectators when we design social games [78]. Games that involve physical performance often generate a spectacle that other potential players observe before playing. So successful design of such games needs to include conscious consideration of the game’s emotional effects upon spectators as well as players. Finally, there is work investigating the design values and properties of ‘supple’ interfaces from the Human Computer Interaction literature, which has relevance to evoking social emotions with movement games [79]. Suppleness is a use quality that is defined as including the use of subtle social signals, emergent dynamics, and a focus on moment-to-moment experience (as opposed to end goals or tasks). Successful movement-based social games may be more likely to have suppleness as a characteristic, and suppleness may be of value in guiding design decisions for movement-based games meant to evoke positive emotions.

Practice

In the past 10 years, there has been a rapid acceleration in the number of movement-based social games created for both research and commercial purposes. This has been facilitated by the introduction of movement-controllers for the major game consoles (Nintendo Wii, Sony Move, Microsoft Xbox Kinect), and by the rapid spread of sensor-enabled smart phones and increased bandwidth of network connections (see for example the indie game *Bounden*, Fig. 14.3). Researchers interested in the emotional effects of social movement games have been able to use these platforms and other readily available components and hardware elements to construct games with which to study the impact of social movement mechanics. Some examples include The Exertion Games Lab’s *I-dentity* and *Musical Embrace* [80, 81]; the NYU Game Innovation Lab’s *Wriggle*, *Yamove*!, and *Pixel Motion* [61, 82, 83]; and the *Oriboo* [5]; and the socially aware interactive playground work done at Twente University [84].

Fig. 14.3 *Bounden* (2015) is a smartphone-based game that requires two players to each have their thumb on the screen, working together to keep a virtual sphere visible and move it through a path of rings by tilting and rotating the device together. The moves that result were actually choreographed by the Dutch National Ballet, ensuring a (somewhat) graceful result; image used with permission

There has also been some effort to aggregate findings about the design and impact of social movement games. Mueller and Isbister engaged in an aggregation of best design practices in the form of ten movement game guidelines [6, 76], which include information about designing to facilitate social fun. Márquez-Segura and Isbister wrote a chapter aggregating recent research on co-located physical social play, which includes detailed descriptions of the *Yamove*! the *Oriboo* systems and accompanying research work [77]. This chapter highlights the importance of making the best use of technology, setting, and players as design material; allowing for and embracing player influence and impact when shaping gameplay; and encouraging and protecting the 'we' in social play.

Future Work

Improving Sensing of Emotional Cues

As discussed in section "The Body as a Means for Expressing Emotions", systems are becoming capable of interpreting the emotional content expressed through non-verbal behavior, including body expressions. However, this capability has not yet been extensively engaged by computer games, though examples have begun to appear. As sensors become cheaper and ubiquitous, there is still the need to fully understand which affective dimensions can be captured through the set of sensors available (e.g., full body motion capture system vs smartphone), especially when these provide minimal datapoints.

At the same time, as games are ubiquitous, it is also time to consider that the sensing technology available to track people's body expressions may not be predefined, and that different devices may be available at different stages of a game's life cycle. This is particularly important not just in the entertainment context. A recent study by Singh et al. [63] show that gamified physical rehabilitation should be designed with a mobile and ubiquitous model in mind, to facilitate transferring of skills from physical exercise sessions to everyday functional movements. In addition, the social aspects also suggest and invite researchers to consider measuring not just individual players' emotions but group emotions as well as audience emotions. For example, new body-based measures able to capture the level of bonding within the group, and congruency of emotions between people in the group are needed. It could be interesting to detect the emotion group leader and support that person in altering or regulating the emotional states of the group.

Most work is still focused on measuring visible body expression, missing important information that is not easy to track using motion sensors. For example, tension of the muscles in the arms, which may indicate readiness to act in a specific way. Work by Huis in t'Veld [85, 86] has shown the existence of muscle activity patterns that relate to particular emotions. This work is still very preliminary and calls for using games as ways to study this relationship and to exploit it toward better personalization of the game experience. Finally, an affective channel not fully exploited in the game context even if ubiquitously present, and increasingly finely measured, is touch behaviour. A large body of research shows that touch is a powerful affective modality through which people express their emotion, communicate emotions to others [87] and also express what they feel about objects [88]. For example, Sae-Bae et al. [89] showed that touch-based authentication gestures were more pleasurable as well as more secure than standard text-based passwords. Gao et al. [90] shows that using touch behaviour during a touch-based smartphone game, the system could detect people's affective states with very high performance (see Table 14.1 for details).

Improving Body-Based Game Evaluation for Social Games

In studying movement-based social games, researchers use game logs, video recordings, interviews, and post-play surveys to understand impacts on players. Understanding of players' emotions has been a small part of the overall set of research questions and measures in extant studies, and so there is as yet very little detailed information about how to evoke particular social emotions given particular design choices. Designers need to be able to unpack at a reasonably granular level what is happening emotionally and when for players, so they can build emotional evaluation into prototyping and iteration of these games. So far, this is time consuming and difficult—it can take many hours to code video logs, and not all emotions are legible using these records. Self-report of emotion during gameplay disrupts the experience and post-surveys and interviews can only give more fuzzy, aggregate impressions [77]. There is a continuing need for more sophisticated evaluation techniques for capturing the nuances of social emotions during gameplay. Ideally, researchers could use some combination of unobtrusive physiological and self-report measures, triangulated with game log data, to get a good picture of what is happening emotionally for players and why.

In terms of design practices, there is a continuing need for dialog between commercial game developers and academic researchers, toward capturing craft-based tacit knowledge and propagating it more broadly to future social movement game designers, including those in the games for impact sector who must make their design process and criteria more explicit, tethering these choices to desired outcomes [6, 76].

Conclusions

This chapter provided an overview of the current state of the art in understanding body-based emotion cues and their use in exergames and other body-based game design. Much research has been conducted in support of reading basic emotional signals from the body, and some progress has been made in incorporating this knowledge into game design choices. There are substantial future opportunities for broadening emotion sensing capabilities, designing emotion into body-based games, and evaluating their impact. To date, there has not been much crossover between research communities considering input sensors and game outputs, and those that consider affective user experience sensing and analysis. In future, it could be fruitful to merge these lines of thought, in order to more richly understand what is happening for players, and become more methodical and sophisticated about designing body-based effects in games, including therapeutic and other ‘serious’ games uses (for example, sensory integration, pain management, and self perceptions related to the body). Merging these perspectives might also allow for increased sophistication in evoking complex emotions, enabling the examination of and design for higher order constructs such as creativity and team feeling.

References

1. Damasio AR (1994) Descartes’ error: emotion, reason and the human brain. Avon Books, New York
2. de Gelder B (2009) Why bodies? Twelve reasons for including bodily expressions in affective neuroscience. Philos Trans R Soc 364(3):3475–3484
3. Sinclair J, Hingston P, Masek M (2007) Considerations for the design of exergames. Proc GRAPHITE’07 1:289–295

4. Mueller FF, Edge D, Vetere F, Gibbs MR, Agamanolis S, Bongers B, Sheridan JG (2011) Designing sports: a framework for exertion games. In: Proceedings of CHI 2011, pp 2651–2660
5. Márquez Segura E, Waern A, Moen J, Johansson C (2013) The design space of body games: technological, physical, and social design. In: Proceedings of CHI 2013, Paris, France
6. Isbister K, Mueller F (2015) Guidelines for the design of movement-based games and their relevance to HCI. Hum Comput Interact, Spec Issue Games HCI 30(3–4):366–399
7. Kleinginna PR, Kleinginna AM (1981) A categorized list of emotion definitions with suggestions for a consensual definition. Motiv Emot 5:345–379
8. Scherer KR (2005) What are emotions? And how can they be measured? Soc Sci Inf 44(4): 693–727
9. Kleinsmith A, Bianchi-Berthouze N (2013) Affective body expression perception and recognition: a survey. IEEE Trans Affect Comput 4(1):15–33
10. Ekman P, Friesen W (1967) Head and body cues in the judgment of emotion: a reformulation. Percept Mot Skills 24:711–724
11. Paterson HM, Pollick FE, Sanford AJ (2001) The role of velocity in affect discrimination. In: Proceedings of 23rd annual conference of the cognitive science society, Lawrence Erlbaum Associates, pp 756–761
12. Kleinsmith A, Bianchi-Berthouze N (2005) Grounding affective dimensions into posture features. LNCS: Proceedings of 1st international conference on on affective computing and intelligent interaction, pp 263–270
13. Kleinsmith A, Bianchi-Berthouze N, Steed A (2011) Automatic recognition of non-acted affective postures. IEEE Trans Syst Man Cybern Part B 41(4):1027–1038
14. Karg M, Kuhnlenz K, Buss M (2010) Recognition of affect based on gait patterns. IEEE Trans Syst Man Cybern Part B 40(4):1050–1061
15. Kleinsmith A, De Silva R, Bianchi-Berthouze N (2006) Cross-cultural differences in recognizing affect from body posture. Interact Comput 18(6):1371–1389
16. Coulson M (2004) Attributing emotion to static body postures: recognition accuracy, confusions, and viewpoint dependence. J Nonverbal Behav 28:117–139
17. Wallbott HG (1998) Bodily expression of emotion. Eur J Soc Psychol 28:879–896
18. Aviezer H, Trope Y, Todorov A (2012) Body cues, not facial expressions, discriminate between intense positive and negative emotions. Science 338:1225–1229, Issue 30
19. Lange J, Lappe M (2007) The role of spatial and temporal information in biological motion perception. Adv Cogn Psychol 3(4):419–428
20. Atkinson AP, Dittrich WH, Gemmell AJ, Young AW (2007) Evidence for distinct contributions of form and motion information to the recognition of emotions from body gestures. Cognition 104(1):59–72
21. Roether C, Omlor L, Christensen A, Giese MA (2009) Critical features for the perception of emotion from gait. J Vis 8(6):1–32, No 15
22. Laban R (1980) The mastery of movement. Plymouth, UK
23. Bianchi-Berthouze N, Kleinsmith A (2003) A categorical approach to affective gesture recognition. Connect Sci 15(4):259–269
24. Dael N, Bianchi-Berthouze N, Kleinsmith N, Mohr C (2015) Measuring body movement: current and future directions in proxemics and kinesics. In: The APA handbook of nonverbal communication. APA
25. Fourati N, Pelachaud C (2015) Multi-level classification of emotional body expression. In: International conference on automatic face and gesture recognition, pp 1–8. 10.1109/FG.2015.7163145
26. Fourati N, Pelachaud C (2015) Relevant body cues for the classification of emotional body expression in daily actions. In: IEEE proceedings of international conference on affective computing & intelligent interaction
27. Kleinsmith A, Bianchi-Berthouze N (2007) Recognizing affective dimensions from body posture, vol 4738, Lecture Notes in Computer Science. LNCS. Springer, Berlin, pp 48–58

28. Isbister K (2012) How to stop being a buzzkill: designing Yamove!, a mobile tech mash-up to truly augment social play. Proceedings of MobileHCI
29. Camurri A, Mazzarino B, Volpe G (2004) Analysis of expressive gesture: the EyesWeb expressive gesture processing library. Gesture-Based Commun Hum-Comput Interact LNCS 2915:460–467
30. Zacharatos H, Gatzoulis C, Chrysanthou Y, Aristidou A (2014) Automatic emotion recognition based on body movement analysis: a survey. IEEE Comput Graph Appl 34(6):35–45
31. Kleinsmith A, Bianchi-Berthouze N (2011) Form as a cue in the automatic recognition of non-acted affective body expressions, vol 6975, LNCS. Springer, Memphis, pp 155–164
32. Savva N, Scarinzi A, Bianchi-Berthouze N (2012) Continuous recognition of player's affective body expression as dynamic quality of aesthetic experience. IEEE Transact Comput Intell AI Games 4(3):199–212
33. Zacharatos H, Gatzoulis C, Chrysanthou Y, Aristidou A (2013a) Emotion recognition for exergames using Laban Movement analysis. In Proceedings of Motion on Games (MIG '13). ACM, New York, Article 39
34. Zacharatos H, Gatzoulis C, Chrysanthou G (2013b) Affect recognition during active game playing based on posture skeleton data, In: 8th international conference on computer graphics theory and applications
35. Aung MS, Bianchi-Berthouze N, Watson P, C de C Williams A (2014) Automatic recognition of fear-avoidance behavior in chronic pain physical rehabilitation. PervasiveHealth '14 Proceedings of the 8th International Conference on Pervasive Computing Technologies for Healthcare, pp 158–161
36. Aung MSH, Kaltwang S, Romera-Paredes B, Martinez B, Singh A, Cella M, Valstar M, Meng H, Kemp A, Shafizadeh M, Elkins AC, Kanakam N, de Rothschild A, Tyler N, Watson PJ, Williams AC de C, Pantic M, Bianchi-Berthouze N (n.d.) The automatic detection of chronic pain-related expression: requirements, challenges and a multimodal dataset in IEEE Trans. Affective Computing (in press)
37. Olugbade T, Aung MSH, C de C Williams A, Bianchi-Berthouze N (2014) Bi-modal detection of painful reaching for chronic pain rehabilitation systems. ICMI'14, pp 455–458
38. Olugbade TA, Bianchi-Berthouze N, Marquardt N, Williams A CdeC (2015) Pain level recognition using kinematics and muscle activity for physical rehabilitation in chronic pain. IEEE proceedings of international conference on affective computing & intelligent interaction, pp 243–249
39. Griffin HJ, Aung MSH, Romera-Paredes B, McKeown G, Curran W, McLoughlin C, Bianchi-Berthouze N (2013) Laughter type recognition from whole body motion. In: IEEE proceedings of international conference on affective computing & intelligent interaction, pp 349–355
40. Griffin HJ, Aung MSH, Romera-Paredes B, McLoughlin C, McKeown G, Curran W, Bianchi-Berthouze N (2015) Perception and automatic recognition of laughter from whole-body motion: continuous and categorical perspectives. IEEE Transact Affect Comput 6:165–178
41. Mancini M, Varni G, Niewiadomski R, Volpe G, Camurri A (2014) How is your laugh today? In: CHI'14 extended abstracts on human factors in computing systems, pp 1855–1860
42. Niewiadomski R, Mancini M, Varni G, Volpe G, Camurri A (n.d.) Automated laughter detection from full-body movements. IEEE Transactions on Human-Machine Systems (in press)
43. Mancini M, Ach L, Bantegnie E, Baur T, Bianchi-Berthouze N, Datta D, Ding Y, Dupont S, Griffin HJ, Lingenfelser F, Niewiadomski R, Pelachaud C, Pietquin O, Piot B, Urbain J, Volpe G, Wagner J (2014) Laugh when you're winning, innovative and creative developments in multimodal interaction systems. Springer, Berlin, pp 50–79
44. Niewiadomski R, Mancini M, Ding Y, Pelachaud C, Volpe G (2014) Rhythmic body movements of laughter. In: Proceedings of the 16th international conference on multimodal interaction, pp 299–306
45. Griffin H, Varni G, Tome-Lourido G, Mancini M, Volpe G, Bianchi-Berthouze N (2015) Gesture mimicry in expression of laughter. ACII'15

46. Niedenthal PM (2007) Embodying emotion. Science 316(5827):1002–1005
47. Riskind JH, Gotay CC (1982) Physical posture: could it have regulatory or feedback effects on motivation and emotion? Motiv Emot 6(3):273–298
48. Brinol P, Petty R, Wagner B (2009) Body posture effect on self-evaluation: a self-validated approach. Eur J Soc Psychol 39:1053–1064
49. Cacioppo JT, Priester JR, Berntson GG (1993) Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. J Pers Soc Psychol 65: 5–17
50. Casasanto D, Dijkstra K (2010) Motor action and emotional memory. Cognition 115(1): 179–185
51. Wells GL, Petty RE (1980) The effects of overt head movements on persuasion: compatibility and incompatibility of responses. Basic Appl Soc Psychol 1:219–230
52. Carney DR, Cuddy AJC, Yap AJ (2010) Power posing: brief nonverbal displays affect neuroendocrine levels and risk tolerance. Psychol Sci 21(10):1363–1368
53. Botvinick M, Cohen J (1998) Rubber hands 'feel' touch that eyes see. Nature 391:756, Issue *39*
54. Tsakiris M (2010) My body in the brain: a neurocognitive model of body ownership. Neuropsychologia 48(3):703–712
55. Tajadura-Jimenez A, Tsakiris M, Marquardt T, Bianchi-Berthouze N (2015) Action sounds update the mental representation of arm dimension: contributions of kinaesthesia and agency. Front Psychol 6:689
56. Lindley SE, Le Couteur J, Bianchi-Berthouze N (2008) Stirring up experience through movement in game play: effects on engagement and social behaviour. In: SIGCHI conference on human factors in computing systems, pp 511–514
57. Berthouze NK, Kim W, Darshak P (2007) Does body movement engage you more in digital game play? And why? Lect Notes Comput Sci LNCS 4738:102–113
58. Pasch M, Bianchi-Berthouze N, van Dijk B, Nijholt A (2009) Movement-based sports video games: investigating motivation and gaming experience. Entertain Comput 1(2):49–61
59. Nijhar J, Bianchi-Berthouze N, Boguslawski G (2012) Does movement recognition precision affect the player experience in exertion games? Int Conf Intell Technol Interact Entertain (INTETAIN) LNICST 78:73–82
60. Melzer A, Derks I, Heydekorn J, Steffgen G (2010) Click or strike: realistic versus standard game controls in violent video games and their effects on agression. In: Yang HS, Malaka R, Hoshino J, Han JH (eds) 9th International Conference, ICEC 2010. Springer, Berlin
61. Isbister K, Schwekendiek U, Frye J (2011a) Wriggle: an exploration of emotional and social effects of movement. In: Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, pp 1885–1890
62. Bianchi-Berthouze N (2013) Understanding the role of body movement in player engagement. Hum Comput Interact 28(1):42–75
63. Singh A, Piana S, Pollarolo D, Volpe G, Varni G, Tajadura- Jiménez A, Williams A CdeC, Camurri A, Bianchi-Berthouze N (n.d.) Go-with-the-flow: tracking, analysis and sonification of movement and breathing to build confidence in activity despite chronic pain. HCI (in press)
64. Singh A, Klapper A, Jia J, Fidalgo A, Tajadura-Jimenez A, Kanakam N, Bianchi-Berthouze N, Williams A (2014) Motivating people with chronic pain to do physical activity: opportunities for technology design. In: Proceedings of the 32nd ACM conference on human factors in computing systems, pp 803–2012
65. Bresin R, de Witt A, Papetti S, Civolani M, Fontana F (2010) Expressive sonification of footstep sounds. Proceedings of ISon
66. Tajadura Jimenez A, Basia M, Deroy O, Fairhurst M, Marquardt N, Bianchi-Berthouze N (2015) As light as your footsteps: altering walking sounds to change perceived body weight, emotional state and gait. In: Proceedings of the SIGCHI conference on human factors in computing system

67. Hatfield E, Cacioppo JT, Rapson RL (1994) Emotional contagion. Cambridge, Cambridge University Press
68. Marsh KL, Richardson MJ, Schmidt RC (2009) Social connection through joint action and interpersonal coordination. Top Cogn Sci 1(2):320
69. Valdesolo P, DeSteno D (2011) Synchrony and the social tuning of compassion. Emotion 11(2):262
70. Hall ET (1968) Proximics. Curr Anthropol 9(2–3):83
71. Knapp ML, Hall JA (2002) Nonverbal communication in human interaction, 3rd edn. Holt, Rinehart & Winston, New York
72. Huizinga J (1955) Homo Ludens: a study of the play-element in culture. Beacon Press, Boston
73. Salen K, Zimmerman E (2004) Rules of play: game design fundamentals. MIT Press, Massachusetts
74. Stenros J, Paavilainen J, Mäyrä F (2009) The many faces of sociability and social play in games. In: Proceedings of the 13th International MindTrek Conference: everyday life in the Ubiquitous Era, MindTrek'09. ACM, New York, pp 82–89
75. Simon B (2009) Wii are out of control: bodies, game screens and the production of gestural excess. Loading 3(4). http://journals.sfu.ca/loading/index.php/loading/article/viewArticle/65
76. Mueller F, Isbister K (2014) Movement-based game guidelines. In: Proceedings of the SIGCHI conference on human factors in computing systems
77. Márquez Segura E, Isbister K (2015) Enabling co-located physical social play: a framework for design and evaluation. In: Bernhaupt R (ed) Game user experience evaluation, Springer, Switzerland, pp 209–238. http://www.springer.com/us/book/9783319159843
78. Reeves S (2011) Designing interfaces in public settings: understanding the role of the spectator. Human-computer interaction. Springer, Berlin
79. Isbister K, Höök K (2009) On being supple: in search of rigor without rigidity in meeting new design and evaluation challenges for HCI practitioners. In: Proceedings of the SIGCHI conference on human factors in computing systems
80. Huggard A, De Mel A, Garner J, Toprak C, Chatham A, Mueller F (2013) Musical embrace: understanding a socially awkward digital play journey. DiGRA, Atlanta, Georgia
81. Garner J, Wood G, Pijnappel S, Murer M, Mueller F (2014) I-dentity: innominate movement representation as engaging game element. In: Proceedings of the SIGCHI conference on human factors in computing systems
82. Isbister K (2012) How to stop being a buzzkill: designing Yamove!, a mobile tech mash-up to truly augment social play. MobileHCI'12
83. Robbins H, Isbister K (2014) Pixel motion: a surveillance camera enabled public digital game. In: Proceedings of foundations of digital game
84. Moreno A, van Delden R, Poppe R, Reidsma D (2013) Socially aware interactive playgrounds. Pervasive Comput 12:40–47
85. Huis in t'Veld EMJ, Van Boxtel GJM, de Gelder B (2014) The body action coding system I: muscle activations during perception and activation of emotion. Soc Neurosci 9(3):249–264
86. Huis in t'Veld EMJ, Van Boxtel GJM, de Gelder B (2014) The body action coding system II: muscle activations during perception and activation of emotion. Behav Neurosci 8:330
87. Hertenstein MJ, Holmes R, Mccullough M, Keltner D (2009) The communication of emotion via touch. Emotion 9(4):566–573
88. Atkinson D, Orzechowski P, Petreca B, Bianchi-Berthouze N, Watkins P, Baurley S, Padilla S, Chantler M (2013) Tactile perceptions of digital textiles: a design research approach. In: Proceedings of the SIGCHI conference on human factors in computing systems
89. Sae-Bae N, Ahmed K, Isbister K, Memon N (2012) Biometric-rich gestures: a novel approach to authentication on multi-touch devices. In:Proceedings of the SIGCHI conference on human factors in computing systems
90. Gao Y, Bianchi-Berthouze N, Meng H (2012) What does touch tell us about emotions in touchscreen-based gameplay? ACM Transact Comput Hum Interact 19(14):31
91. Siddiquie B, Amer M, Tamrakar A, Salter D, Lande B, Mehri D, Divakaran A (2015) Tower game dataset: a multimodal dataset for analyzing social interaction predicates. ACII'15

92. Lund HH, Klitbo T, Jessen C (2005) Playware technology for physically activating play. Artif Life Robot J 9:165–174
93. Yannakakis GN, Hallam J (2008) Entertainment modeling through physiology in physical play. Int J Hum-Comput Stud 66(10):741–755
94. Volkova E (2014) Expressions in narrative scenarios and across cultures. PhD thesis, Tubingen University. https://publikationen.uni-tuebingen.de/xmlui/handle/10900/58044