Dance, language and the brain

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Abstract: This paper explores the relationship between dance and language in the light of recent findings from linguistics, cognitive neuroscience and evolutionary psychology. I will argue that at a formal level of sentence construction dance and language share many characteristics, but that the analogy breaks down at the level of meaning, reference, truth and function. With this in mind, I will argue that dance and language build on a shared cognitive architecture and may have a joint evolutionary origin. Finally, I will show how the analysis of language may be put to creative use.

Keywords: dance; language; brain; cognitive science; grammar; metaphor.

Reference to this paper should be made as follows: Hagendoorn, I. (2010) 'Dance, language and the brain', *Int. J. Arts and Technology*, Vol. 3, Nos. 2/3, pp.221–234.

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1 Introduction

In his treatise on 16th century renaissance dance, first published in 1589, the French cleric and dance theorist Jehan Tabourot, writing under the name Thoinot Arbeau, wrote that "most of the authorities hold that dancing is a kind of mute rhetoric by which the orator without uttering a word, can make himself understood by his movements" (Arbeau, 1966, p.16). He was neither the first, nor would he be the last, to relate dance to language. Three centuries later, the French poet Stéphane Mallarmé (1842–1898) declared that "[the ballerina] writing with her body, suggests things which the written word could express only in several paragraphs of dialogue or descriptive prose. Her poem is written without the writer's tools" (Mallarmé, 1983, p.112). And in one of the oldest discourses on dance, Plutarch (46–120 AD) wrote that "we may aptly transfer what Simonides said of painting to dancing, and call dancing mute poetry, and poetry speaking dancing" (Plutarch, 1909). The philosopher Robin Collingwood even went so far as to argue that all kinds of language have a relation to bodily gesture – painting, drawing and music for instance, imply the movements of the artist's or musician's hand – and that "in this sense it may be said that the dance is the mother of all languages" (Collingwood, 1958, p.244).

Various authors have contemplated these claims, arguing that, no, dance is not a language (e.g. Sparshott, 1995), or that yes, we can meaningfully compare our understanding of dance with our understanding of language, as long as we abstract from the natural language analogy (e.g. McFee, 1992).

In recent years, considerable advances have been made in our understanding of language and its cognitive underpinnings. The present article reviews some of these developments and shows how they may shed a new light on the relationship between dance and language. The structure of the article is as follows. Firstly, I will briefly consider some arguments for and against viewing dance as a language. I will then discuss three distinct perspectives on the cognitive foundations of language. Based on recent findings from evolutionary anthropology I will argue that at some stage dance and language may have co-evolved. The much publicised discovery of mirror neurons has the potential of offering new insights into the brain structures supporting both language and dance. However, I will argue that in dance one can find examples that challenge the current research paradigm. Building on the work of Fauconnier and Turner (1998, 2002), I will tentatively sketch some of the cognitive mechanisms by which meaning may emerge in language and dance. Finally, I will show how the analytical tools with which language can be analysed can be put to artistic use as instruments of choreographic creation.

2 Dance and the language metaphor

When analysing the parallels between dance and language, we would need to explain what we mean both by 'dance' and 'language' and make explicit the nature of the connection we are trying to make. Are we talking about natural languages or about a formal language in the mathematical sense? And when we talk about dance do we mean dance as an artform or any form of dance? As we shall see an answer to these questions determines how we should read the analogy.

It could of course be that, when dance is referred to as a language, language is merely used as a metaphor. But that begs the question. Why not say that dance is geometry in the flesh or that it is architecture in motion? Why not say, as the 18th century French choreographer and dance theorist Jean-Georges Noverre wrote in his *Lettres sur La Danse et sur Les Ballets* (Noverre, 1983, p.10), that "a ballet is a picture, or rather a series of pictures connected with the other by the plot which provides the theme of the ballet"?

As George Lakoff and Mark Johnson argue in *Metaphors We Live By* (1980), metaphors highlight some aspects of our experience while masking others. Each of the above metaphors makes sense, although some more than others, because each highlights a different aspect of dance. Thus, the language metaphor may highlight the fact that dance employs gesture to express and communicate intention and emotion. People gesture when they speak, raise their fists in anger, shrug their shoulders in doubt, frown upon a question, jump with joy and use elaborate body movements to make themselves clear when misunderstood. As a whole, these gestures are sometimes referred to as body language and we may then subsume dance under this more general notion, except of course that the term body language is itself a metaphor in need of explanation.

Language itself has different meanings depending on the context in which it is used. We speak of natural languages, but also of programming languages such as C++, Perl and

Java, and this provides us with another sense of the language metaphor. Although one cannot translate everyday language into a programming language like C++, code written in one language can, in principle, be translated into another, while the code itself expresses an algorithm that specifies the behaviour of a computer. If a piece of choreography is viewed as a set of instructions that specifies the actions of the dancers, we might therefore similarly speak of a certain choreographer's choreographic language.

The language metaphor is not confined to the word language as such, but includes the usage of language-related notions such as speaking, writing, words, phrases, vocabulary, grammar, syntax, poetry and so on, each of which may draw attention to a specific analogy. But metaphors only take us so far and we should not read too much into them. The fact that we speak of brain waves, brainstorms and depressions does not mean that the brain is like an ocean or a meteorological system. So whenever someone speaks of dance as the poetry of human motion (e.g. Williams, 2004, p.4) we may ask: Why poetry? Why not prose? And if poetry; what kind?

3 Vocabulary, phrases and syntax

In dance, terminology movement sequences are often referred to as phrases, while the collection of individual positions and movements is referred to as a vocabulary. As the American choreographer Doris Humphrey (1895–1958) wrote in her book *The Art of Making Dances*

> "[a] good dance should be put together with phrases, and [a] phrase has to have a recognisable shape, with a beginning and an end, rises and falls in its over-all line, and differences in length for variety" (Humphrey, 1959, p.68).

A phrase is therefore more than a mere sequence of movements. It has a structure, a beginning and an end.

The best-known dance vocabulary is probably the classical ballet vocabulary. It consists of numerous movements and positions which can be combined in an infinite number of ways, although various rules restrict the ways in which movements can be performed just as the rules of grammar limit the number of correct phrases. Thus, a *battement*, which can be described as a kicking or beating movement of the working leg, is performed in front, to the side or to the back of the body, but never diagonally. These rules are largely implicit. They are handed down from teacher to student and determine what 'proper' ballet is.

Equally extensive, but less known dance vocabularies can be found in the traditional Khmer dance from Cambodia (Cravath, 1986) and Balinese dance (Davies, 2007). Perhaps the oldest and most elaborate dance system is the classical Indian dance form *bharata natyam*, first described in the ancient Sanskrit text Natya Shastra. There is some debate among dance scholars as to the authenticity of what is today known as bharata natyam (see Allen, 1997 for a discussion). What is beyond dispute though is that there is a tradition which goes back at least 2000 years.

Bharata natyam today is a living artform. There are various styles and traditions and any account depends on the dancer or *guru* consulted. An interesting feature of bharata natyam is that some movements have a symbolic meaning and that the dance itself can be either abstract or representational in which case the dance conveys a story, usually a legend from Indian mythology. The basic element of bharata natyam is the *adavu*, a

composite movement in which torso, arms, hands, legs and feet move in a coordinated pattern. A series of adavus can be combined to form a phrase called *jathi*. The *adavus* can be punctuated with a number of expressive hand movements, the *hastas*, performed with either one or both hands. In addition, there are a number of head, neck and eye movements, the *bhedas*, as well as a number of transitional movements of the whole body called *karanas*, which are usually maintained for a fraction of a second, contributing to the characteristic, and slightly staccato look of bharata natyam. Even though some of the hastas are mimetic – a diagonal top-down zigzag movement of the hand depicts lightning, making waves with the hand depicts a river etc. – bharata natyam is different from pantomime in that movements can also be used symbolically. A sudden release of the head and arms may symbolise death and a stretched arm drawing the upper half of a large circle may stand for heaven. What is more, the same gestures that refer to an object – a bee, the moon or a lotus flower – can also stand for longing, anger and so on, just as the words in spoken language can be descriptive as well as metaphorical.

The analogy between dance and language is therefore sustained by a number of structural similarities. In the terminology of linguistics, we might say that in dance too there are formation rules, constraints in the form of anatomical and aesthetic restrictions, derivational rules or transformations and a lexicon. Different dances, from break-dance to flamenco, are then defined by differences in each of these elements.

4 Reference, truth and function

Now that the full extent of the diversity in the world's languages is becoming clear (Evans and Levinson, forthcoming); some arguments against viewing dance as a language, which implicitly take English or another modern European language as a point of reference (e.g. Sparshott, 1995), for instance that it does not have tenses and pronouns, no longer hold. There is, however, a number of functional aspects in which dance and language differ.

A descriptive sentence is either true or false. This is a fundamental property of language. The sentence 'the cat is on the mat' is true, if there is a cat and a mat and if the cat is on the mat and not behind it or on the windowsill. However, dance does not communicate propositions that can be true or false. A ballet teacher may correct a student if her *port de bras* is wrong and a performance can be wrong if a dancer turns right instead of left, but that does not make the phrase, the sequence of movements itself, false. Whereas two speakers can argue and come to an agreement, two dancers can at best converge upon a sequence of movements that flows nicely, feels good or is aesthetically pleasing. Dance can tell stories, as in bharata natyam, but it cannot be used to gossip or to pass on knowledge about another subject. There are no equivalents in dance either of first-order logic and you cannot solve differential equations in dance. The same can be said of the gestures that are often referred to as body language, which for that reason do not constitute a language proper either. I am aware that a work of art may be seen as manifesting its own 'truth', precisely because there are no criteria to determine its truth or falsehood by. In the ordinary sense of the word it still would not make sense to say of a dance piece that it is true.

Language theorists tend to be obsessed with declarative sentences and their truth value, but as Jackendoff (2002, p.328) notes, there is more to language than simple assertions. We ask questions, make requests, formulate problems and give orders. We

acknowledge, threaten and make promises all by uttering a few words. We may let $x = 4y$, offer to take a break, give instructions as to how to proceed and, thrilled by an exhilarating dance performance, exclaim that it was great! It is hard to think of equivalent phrases in dance that perform the same function.

To summarise, we could say that at a formal level of sentence construction dance and language share many characteristics. The analogy breaks down at the level of meaning, reference, truth and function. To put it differently, at the level of *syntax* there is a strong analogy between dance and language, at the level of *semantics* dance and language diverge. If in the previous paragraph I have dwelled on bharata natyam, it is to highlight the existence of an ancient dance in which single movements are endowed with meaning and in which entire stories can be told.[1]

The similarities and differences between dance and language raise the question as to their respective evolutionary origins, cognitive foundations and neural substrates. Is dance cognitively related to the capacity for language? Does it build on an evolutionary more ancient language capacity? Did language, dance and perhaps music, have a common evolutionary origin and did the evolution of dance and language move in separate directions with the emergence of speech and with story-telling taking over the role of pantomime?

5 The gestural origin of language

The idea that language has its origins in gestural communication goes back at least to the 18th century philosopher Étienne Condillac. In recent years, this theory has gone through a revival in the wake of research into gestures that accompany speech (Goldin-Meadow, 1999), reports about a community of deaf children in Nicaragua and members of the al-Sayyid Bedouin tribe in the Negev desert who developed their own sign language (Sandler et al., 2005; Senghas et al., 2004), the discovery of mirror neurons in the monkey brain (Gallese et al., 1996) and a growing body of research comparing language acquisition in children and primate communication (e.g. Tomasello et al., 2005 and Tomasello, 2008).

According to the evolutionary anthropologist and developmental psychologist Michael Tomasello (2008), human communication cannot have started with language as a coded system, whether as whistling, grunting or yelling, since it assumes a prior form of communication to establish the code (think of joining hands and lifting the tree when I say 'yes' or 'go'). Tomasello argues that natural gestures such as pointing and pantomiming are the best candidates for such an uncoded form of communication: they were not only the first uniquely human forms of communication to arise in evolution, but are also the first means of communication to emerge in children's development. He dismisses much of the comparative data often cited in favour of a vocal origin of language. Vervet monkeys for example, may be capable of extracting information about the nature of a threat from an alarm call, but they call out to no one in particular and continue making alarm calls long after other members of the group are in safety. They therefore do not appear to be capable of intentionally warning a particular individual.

Tomasello points out that, while their vocal displays are mostly unlearned, involuntary, inflexible and tied to emotionally salient events, monkeys and apes possess a large stock of gestures that are both individually learned and flexibly produced. These gestures can be distinguished into intention-movement gestures, which the ape employs

to get another ape to do something when it is watching, and attention-getting gestures, which it uses to draw the attention of another either to itself or to some object with the apparent expectation that the other performs some desired action. What the apes do not do and what therefore appears to be a human adaptation is to first make an attention-getting gesture followed by an intention-movement gesture. Instead the ape will move so that the other can see it before making an intention-movement gesture. What apes do not do either is to engage in activities involving shared intentions and joint attention, a skill which in human children develops in the first 14 months of life. I would like to add that, along with some bird species, humans are also the only species to put up a performance for one or several specific individuals to watch.[2]

Tomasello hypothesises that the skills and motives for shared intentionality evolved in the context of collaborative activities. But perhaps dance too may have had an instrumental role within this context. Dance can take the form of an individual exploring the possibilities of the body, think of a young foal jumping around in a meadow. This form of dance may derive from what is called locomotory play. It can also take the form of two dancers fooling around, to put it a little irreverently, in which we can see traces of different forms of social play. Finally in what appears to be unique to humans, a group of dancers can synchronise their movements, a phenomenon perhaps most visible in military marches, which the historian McNeill (1995) has argued may have played a pivotal role in human history. I do not have any evidence to support the claim that dance may have been instrumental in the evolution of language, but it is interesting to observe that one particular gene, the AVPR1a gene, has been associated both with an implied proclivity for dancing (Bachner-Melman et al., 2005) and social bonding (Walum et al., 2008). Taken together this suggests that social dancing and social bonding may have a common genetic origin.

As Tomasello argues, we understand others not just because we speak the same language, but because we share a conceptual common ground and, in the final instant, as also pointed out by Wittgenstein (1953, e.g. 23 and 206), a form of life.[3] To an outsider, the fragmented conversations of an audience leaving a theatre may sound like gibberish, but for the audience it is a way to share their experience and relive the moment. According to Tomasello, the ability to construct a common ground and a joint attentional framework is uniquely human and emerges at a distinct stage in human development. This raises the question as to the brain structures that support this capacity and the capacity for pantomime, about which Tomasello remains largely silent.

6 The mirror system hypothesis

In 1996, a group of Italian neuroscientists discovered a class of neurons in a sub-region of the pre-motor cortex of the macaque monkey that responded both when the monkey executed an object-directed movement such as grasping and when the monkey observed someone else performing the same movement. The presence of a target in this setting is crucial. The neurons did not respond to the sight of an intransitive movement or if a grasping movement was mimicked in the absence of an object. This discovery has led to an avalanche of papers aiming to find the human equivalent of the monkey mirror neurons, as they have been termed, and an even greater number of speculative papers about the possible functional role of mirror neurons in cognition and behaviour. It has been suggested that, among other things, mirror neurons mediate action understanding

(Rizzolatti et al., 2001), empathy (Gallese, 2001), imitation learning and the evolution of language (Rizzolatti and Arbib, 1998).

Amidst all this excitement, it is often overlooked that mirror neurons have only been directly demonstrated in monkeys. Neuroimaging studies aiming to identify the brain regions supporting a human mirror system typically assume that if a certain brain region is activated both when a person observes a video of a movement and either imitates or subsequently performs the same movement from memory, it probably represents 'mirror activity'. However, this methodology does not discriminate between 'mirror neuron activity' and other processes relevant to the task (Dinstein et al., 2008). It also fails to discriminate between movements. Surely, there is a difference between an ordinary, untrained person lifting his leg as high up as he can and a dancer doing the same. Since the instruction is identical the neural activity pattern at the planning stage, supposed to be mediated by the pre-motor cortex, is also likely to be similar. Yet the dancer will reach much higher and keep her leg stretched and so the movements are different. In general, studies aiming to assess the properties of the mirror system do not discriminate between movement dynamics and kinematics. This reduces the relevance of present experimental findings for an understanding of dance.

Rizzolatti and Craighero (2007) concede that the mirror system only represents movements that are part of one's own motor repertoire and that other movements are recognised on a visual basis. But this raises the question how a mirror neuron might become tuned to a novel movement. And what is meant by motor repertoire? Is it defined by action objectives, or by movement kinematics? Does grasping an object in front of the body and above the head define the same action? And what about grasping and snatching in which case the only significant difference in terms of observable movement parameters is the speed of execution? The goal of both actions is identical, getting hold of the desired object. The sub-goal in snatching is to grab it without or before the other person noticing. When assessing the possible role of the mirror system in language and non-verbal communication we should therefore bear in mind that the status of many experimental findings and their conceptual foundations are as yet controversial.

The 'Mirror System Hypothesis' which posits that mirror neurons mediated the evolution of the language-ready brain, was given in, in part, by the observation that the region in the monkey brain where mirror neurons were originally discovered appeared to have its human homologue in Broca's area, an area that has been implicated in a variety of language comprehension and production tasks. In many subsequent papers, this conjecture was taken as a fact, but recent findings have called it into question (Toni et al., 2008). In its extreme form, the claim is that

"mirror neurons create a direct link between the sender of a message and its receiver. (..) The observation of an individual grasping an apple is immediately understood because it evokes the same motor representation in the parieto-frontal mirror system of the observer" (Rizzolatti and Craighero, 2007, p.778; Rizzolatti et al., 2001).

Except, of course, that even in this simple example it is by no means clear why the person grasping the apple is doing so and what he is going to do next. Weigh it? Eat it? Smell it? Look at its skin to see if it is suitable for eating? Throw it away perhaps? The direct-matching hypothesis is attractive because of its simplicity, but it fails to capture key features of language and communication. To understand a move in chess one has to understand chess. One does not learn chess by observing someone picking up the pieces, but by studying the rules and playing it.

An alternative 'Mirror System Hypothesis' has been put forward by Arbib (2005). In its most recent incarnation, this hypothesis distinguishes seven stages in the evolution of language. Starting from a system for the cortical control of hand movements (1) a mirror system for grasping (2) and a simple imitation system for object-directed grasping (3) evolved. This system evolved into a complex imitation system for grasping (4) supporting the ability to recognise that an unfamiliar action sequence can be approximated by combining a set of known actions. The capacity for complex imitation evolved into a manual-based communication system with an open repertoire of 'proto-signs' (5), which gave rise to an expanding spiral of conventionalised manual, facial and vocal communicative gestures (6) and finally, the development of syntax and compositional semantics to yield language as we know it (7). In this functional formulation, the 'Mirror System Hypothesis' does not rely on the existence of mirror neurons *per se*. What is needed in functional terms is a system for matching movement perception and execution, which, in principle, could be distributed over a larger neural network. In addition, as Donald (1991) has argued, since learning in animals is mostly dependent on environmental triggers, before they acquired the capacity for pantomime, early hominids first had to evolve the capacity for the voluntary recall of stored motor memories, as well as a supra-modal, domain-general capacity for controlling movement facilitating the transfer of a movement from one limb to another.

Against gestural origin theories, it is often objected that one would expect some evidence for, or remnants of, more elaborate sign systems. Yet the first known sign language for the deaf is about 500 years old (Emmorey, 2005). As Deacon (1997, p.362) writes

> "If something analogous to American Sign Language long predated spoken languages and served as the bridge linking the communication processes of our relatively inarticulate early ancestors, then we should expect that a considerable period of Baldwinian evolution[4] would have specialised both the production and the perception of manual gestures".

According to Deacon, the absence of such a gestural predisposition suggests that the vast majority of Baldwinian evolution for language has taken place with respect to speech. But this is not quite correct. Evidence for a Baldwinian predisposition towards gestural communication can be found in the ease and frequency with which gesture-based systems emerge in noisy environments where speech does not work, such as the trading floor of a derivatives exchange and the gestures used by airport marshals or where communication has to be covert as in beach volleyball. And as the example of bharata natyam illustrates, some gestural-based dance systems pre-date the oldest known sign languages and may even constitute a simple, albeit not full-blown, language, capable of forming rudimentary phrases and telling stories.

What is interesting about these speculations about the gestural origins of language is that some of the capacities that had to evolve to make the emergence of language possible also had to be in place for dance to evolve. It is for this reason that if we were to learn more about the brain structures that support dance, we may also learn more about the neural mechanisms subservient to the capacity for language.

7 Conceptual integration and meaning

There are only so many words and only so many gestures one can make, but meanings are innumerable. For one thing, the meaning of a word or a sentence changes with the context in which it appears. *The red pencil* may refer to a red coloured pencil, a red-writing pencil, a pencil with a red tip or the correction tool in a computer application. But how do we produce all these meanings? And how do we make the leap from reading a word or a novel or seeing a dance performance to grasping its meaning?

When trying to figure out what gets wetter and wetter the more it dries, we consciously imagine various objects that might satisfy this cryptic description. We may reread the sentence several times in search of another hidden meaning, before either giving up or realising that it is a towel. At this moment, we recognise that the verb to dry is used in the sense of 'causing to become dry' and not in the sense of 'becoming dry' and that 'the more' refers to 'the more [objects]' and not to 'getting drier'. The process by which this riddle is constructed and solved is an example of what Fauconnier and Turner (1998, 2002) have termed conceptual integration or blending. In their view, the capacity for conceptual integration is fundamental to human cognition and in its most advanced form also underlies the capacity for language.

Conceptual integration operates across mental spaces, which can be described as some kind of temporary thought assemblies, and is governed by several principles involving the various conceptual relations that can obtain between different mental spaces, such as part-whole, cause-effect, identity and so on. If someone were to say that, when she was 20 she had long hair, we create an identity relation between now and then and imagine a blended space in which the person has long hair. Conceptual integration comes in various degrees of complexity. In a mirror network, the input spaces share a single organising frame. In many of Picasso's cubist portraits, different views of a nose and a mouth are combined into a single presentation, but the organising frame is the shape of a face. In its most complex form, which Fauconnier and Turner call double-scope blending, the two input spaces have different and possibly clashing organising frames. The blended frame is a projection of elements of both input frames, but also has a structure of its own.

The products of conceptual integration can become engrained in lexical structures. At first 'computer virus' integrated elements from the realm of biology and the world of computers to indicate a malicious, self-replicating, unwanted computer program. But as they became more common the 'computer' was dropped so that 'having a virus' now means that one's computer is infected. The same logic also applies to gestures or what Lakoff and Johnson (1980) termed 'experiential Gestalts'. When people get hot from working hard, they take off their jacket and pull up their sleeves. In the blend pulling up one's sleeves may acquire the meaning of getting down to work. In both of these examples, we can reconstruct the meaning by filling in the missing element. When movements, such as stumbling, falling, fleeing, evading, gathering, seeking support and so on, are performed outside of any context and independent of any apparent goal, as they are in a dance performance, we may do the same. We may ask ourselves why these people are falling and what they are fleeing from. And since different people may have different associations, interpretations may vary wildly.

As the above examples show blending is not confined to language. It operates across all domains of cognition. Classical ballet provides us with a fascinating example of a double-scope blend in the form of Odette in *Swan Lake*. The evil sorcerer Von Rothbart

has cast a spell on princess Odette which transforms her into a swan during the day and a human during the night. The fact that she is a blend is key of the story, for when Siegfried aims his crossbow he is so mesmerised by the beauty of one of the swans, which is more that of a girl than of a swan, that he lowers his bow and instantly falls in love with her. At the level of the choreography, the movements do not aim to imitate those of a swan, but try to capture their grace and their essence transposed onto a human body, thus creating a blended figure with a structure of its own.[5] The actual performance provides yet another blend. Some people in the audience may have come to watch Svetlana Zhakharova or Aurélie Dupont, but they see Odette.

To see an expression, a poem or a novel as a blend, one would have to decompose it into two or more input frames. This is straightforward in the case of word combinations such as 'computer virus', but what about dance? Experiments have shown that, when asked to describe everyday events, people tend to segment them into meaningful temporal parts according to sensory characteristics and knowledge structures (Zacks et al., 2007). This may seem straightforward, but interestingly abstract animations too are reliably segmented based on changes in motion such as stops, starts and changes in direction and velocity (Hard et al., 2006). The same processes may also explain how we unconsciously segment a dance performance into scenes, events and actions, which then become the equivalents of phrases, paragraphs and chapters.

Since conceptual integration can be a conscious effort as well as an automatic process, it may also stand in the way of new blends and new meanings. Choreographers have adopted various strategies to deconstruct existing blends and give way to new ways of seeing and constructing meaning. Merce Cunningham famously uses chance operations to determine the order of movements and the spatial organisation of the dancers, thus breaking the natural coherence of movements and events. In minimal dance simple movements are seemingly endlessly repeated, as if someone were reciting the same words over and over again. In Butoh and the work of director Robert Wilson, movements are performed so slowly that the beginning and endpoints blur and any goal or meaning becomes difficult to establish.

8 Tools of analysis as tools of creation

The development of transformational generative syntax revolutionised the study of linguistics, introducing a series of concepts that allowed language to be studied as a formal system. The same theoretical apparatus can also be applied to dance, but since dance performances usually last 20 min or longer and feature multiple dancers, its use is limited to simple and stable systems, such as the indigenous dances studied by dance anthropologists (Williams, 2004). The tools of linguistics can also be put to artistic use though, that is, they can be used not to describe, but to create.

In mathematics, a formal language is defined as a set of strings from an alphabet. A string or word is a finite sequence of symbols from an alphabet. An alphabet is a finite set of symbols and a symbol is an abstract entity that has no meaning by itself. Having thus defined in minimal terms what we mean by language we can also define a grammar $G = (V, T, P, S)$ with V a set of symbols called variables, T a set of symbols called terminal, P a set of productions and S the starting or goal variable from V. The beauty of this formal approach is that it does not matter what we take as symbols. Thus, we can define a set of movements as our symbols and a production 'concatenate', which creates

a string, that is a sequence, of movements from our alphabet. We can also define a production called 'combine', which combines two or more movements from our set into a composite movement, think of moving the arm while walking. Another production might be 'transpose'. Taking advantage of the bilateral symmetry of the body, if a movement was defined for the right arm, 'transpose' transforms it into a movement of the left arm. When defining our own generative dance grammar at some point we may encounter problems that will challenge our creativity. We may for instance run into some anatomical constraints. And does a movement from our alphabet have the same beginning and end point? What if we take a movement such as 'raise arm above head' as a symbol? The arm will remain raised until another operation is applied to it. But, since we are now artists, we can bend our self-defined rules to fit our artistic purposes.

For *Self Meant to Govern* (1994) and *Eidos:Telos* (1995), of which *Self Meant to Govern* is now the first part, the American choreographer William Forsythe created a lexicon of about 130 movements. In this lexicon, every letter of the alphabet stands for one or several words, such as 'brick', 'bottle', 'oyster' or 'zebra', each of which refers to a movement sequence. The movement sequences were choreographed by Forsythe in collaboration with the dancers and were improvised around the words. Thus, 'shower' might take some movements from the shower scene in *Psycho* and 'pizza' might be improvised around opening a pizza delivery box, sticky cheese, etc. Once defined these movement sequences became the building blocks for the piece. During the performance, the dancers could perform the movement sequence connected with the word 'pizza' and subsequently perform 'atlas', which begins with the last letter of the previous word or they could perform 'honey', because it also consists of five letters or because, like pizza, it is food. The dancers could also notice that while performing one movement sequence, say, 'wallet', the elbow and knee might be in the same configuration as in another movement sequence, and then continue with this movement. In addition, the dancers could transform a movement sequence using one of the many dance improvisation techniques, which Forsythe has developed over the years.[6] During the actual performance clocks, with letters instead of digits, were dispersed across the stage and, invisible to the audience, banners with the names of the various improvisation techniques were displayed on both sides of the stage. The dancers navigated through this high density information environment taking cues from the clocks and, armed with a shared language, from each other. The audience, not knowing the concepts that informed the piece, created its own blends of dance and music.

9 Concluding remarks

Dance can take many forms. It can take the form of a dancer dancing alone inside a temple for the all-seeing eye of a deity. It can take the form of a group of kids engaged in a break-dance battle underneath a flyover and of a couple dancing the tango on a sunlit square. It can take the form of a girl rolling her hips in front of her webcam to seduce her boyfriend. And it can take the form of a dancer and choreographer standing on an empty stage in front of 40 people who paid 20 euro each to see him go through the movements of a conductor conducting Stravinsky's *The Rite of Spring*. Does any of this have anything to do with language? The answer is yes, insofar as it relies on a common ground, on shared intentionality, joint attention, imitation, an implicit grammar for stringing together movements, and for lack of a better word, a movement vocabulary,

each of these examples draws on the same cognitive infrastructure as the capacity for language. It is in this too, that dance differs from painting, sculpture and architecture.

Although some birds engage in display behaviour, including dances, humans may be unique in the extent to which they put up performances for others to see and hear. The ability to contemplate dance and art in general requires a predisposition to see the world aesthetically, to view it as a symbol or as 'the expression of some deeper cryptic systematicity' in the words of Deacon (2006, p.49). As Fauconnier and Turner (2002, p.267) claim, this ability depends on the capacity for double-scope blending. No animal climbs into a tree to watch a sunset and no other animal listens to birdsong for the sake of listening. They hear it, but they do not look for a place where they may hear it better.

The present article has sought to survey some recent developments in cognitive linguistics and bring them to bear on dance and choreography. In recent years, various authors have begun to investigate the cognitive and neural foundations of dance (e.g. Brown et al., 2006; Calvo-Merino et al., 2008; Hagendoorn 2004, forthcoming) and a number of interdisciplinary research projects bringing together dance artists and scientists have been launched.[7] This rapprochement between dance and science carries the prospect of not only enriching our knowledge of dance, but also our understanding of language. And perhaps it will also inspire some choreographers to create a new dance language.

Acknowledgements

I would like to thank Avatâra Ayuso and Kalpana Raghuraman as well as the anonymous referees for their comments on an earlier draft of this article.

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Notes

[1] With respect to the ability to tell and read stories in bharata natyam, I rely on reports by individual dancers. I have been unable to find a systematic study that puts side-by-side one dancer's intention and another dancer's understanding for a number of legends.

[2] Some male birds of paradise engage in elaborate display behaviour, sometimes involving dancing, to attract a female.

[3] Reference to proposition number.

[4] Baldwinian evolution refers to the hypothesis that cultural inventions, of which language is a prime example, that are not genetically transmitted may yet bias evolution because individuals with a better capacity for learning may have an adaptive advantage over those with lesser learning capabilities.

[5] As the father explains to the daughter in Gregory Bateson's metalogue *Why a swan?* (Bateson, 2000):

> "I get confused when I speak of the 'swan' and the dancer as two different things. I would rather say that the thing I see on the stage - the swan figure - is both 'sort of' human and 'sort of' swan".

[6] These improvisation techniques have been collected on cd-rom (Forsythe, 1999).

[7] Here, I will mention the Kinesthetic Empathy project (http://www.watchingdance.org) and the Synchronous Objects project (http://synchronousobjects.osu.edu).