Critical review of an area of literature

Stamping, Clapping and Chanting: An Ancient Learning Pathway?

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Contextualisation

It is often the case with contemporary research that a number of fields need to be addressed when answering particular research questions. The review paper that follows draws on philosophy, neurology, cognitive psychology and biomusicology to inform questions related to pedagogy. Working in a number of different fields places substantial demands on the researcher. As is demonstrated below, drawing on diverse fields can allow a successful synthesis of ideas that, in turn, lead to practical proposals for investigation.

Abstract: *In this review I explore the effect of temporal integration as a means of improving learning in schoolchildren. I focus first on theorists that have linked physical activity with a positive effect on children's learning and second to psychological studies that have established the existence of innate temporal patterns. These findings are related to a model of temporal integration that I have developed from Croce's writings on aesthetics (1900). From philosophy to neurology, I discuss recent neurological findings relating to timing and conclude that an organ of temporal integration, regulation and coordination operates in the brain with respect to physical, intuitive and higher cognitive function. I link recent findings in neurophysiology to notably similar findings in recent biomusicological studies. The finding that humans have an involuntary physical response to loud, low-frequency sounds are attributed to an innate legacy of proto-music and proto-dance behaviour among hominids. I develop the model of temporal integration further by examining the literature on stamping and clapping patterns of ancient traditional dances in relation to Husserl's writings on theoretical succession. From philosophy to pedagogy, I summarise the review by proposing stamping, clapping and chanting as a means of achieving improved temporal integration.*

Introduction

Through the application of geometric body movement, the creators of various learning support projects claim to help pupils with reading difficulties. In the 'Brain Gym' system, for example, Dennison and Dennison (1989) address problems caused by the presence according to Goddard (1996) of uninhibited primitive reflexes and other neurological disturbances. They believe that the canals of the labyrinthine inner ear become stimulated by incoming tactile and kinaesthetic sensory information that in turn allows the higher brain centres, responsible for 'fine motor skills and new learning', to be activated and more focused. These exercises within the 'Brain Gym' system are organised according to the laws of natural meridians practised in traditional medicine and therapeutic techniques. In recent years, bodily movement has, in systems such as 'Brain Gym', been linked to the release of learning blockages; however, the idea is not new.

The 'hierarchy of knowledge'[1] proposed by Croce (1900) offers a distinctly post-Cartesian approach to learning. Croce describes the acquisition of 'conceptual knowledge' as being dependent on previously acquired 'intuitive knowledge' and the acquisition of 'intuitive

[1] The 'Hierarchy of Knowledge' first appears in Swanwick (1994, p 29) as a term describing the process of knowledge acquisition set out by Croce (1900).

knowledge' as being dependent on previously acquired 'sensory matter'. I suggest below that the relationship between each level of this hierarchy is likely to involve assimilation, accommodation and regulation of the incoming data. In this study, I focus on the regulatory element of the hierarchical relationships and in particular on cerebellar regulation that processes data at both the sensory level and higher levels of cognitive functioning. In addition, for the purpose of this study, reading is defined as the extraction of meaning from the text through integrated spatial and temporal decoding and sequencing skills. Finely tuned eye-movements that require precision in both timing and coordination with mental faculties are rhythmically regulated as part of the reading process.

Physical movement: 'sensory matter'

Some theorists share all or some of Croce's view (1900). A model of perception presented by Gardner (1973) suggests and analyses the significance of sensory movement in human aesthetic development. This model, set out as a table of 'Modes and Vectors' (1973, p 101) refers to 'modes' as space oriented, as they are concerned with the sizes and shapes of sensory experiences and the 'vectors' as the time oriented aspects of sensory experience. These aspects are all movement centred. The space and time references suggest that the perception of sensory experiences might be usefully classified in these terms and also in abstract spatial-temporal dimensions. I suggest that this idea, configuring sensory experiences in a spatial-temporal matrix, demonstrates a model for objectifying subjective experiences.

Arguably, Gardner's matrix may share some basic concepts with Laban's 'Theory of Movement' (1971). However, Laban's interest in time, space, weight and flow is fundamentally different. Gardner uses these elements to describe the perceptual effect of sensory impressions, whereas Laban uses them to formulate a vocabulary of measurable and classifiable concepts with regard to laws of dance movements (Maletic, 1987, p 22). The idea, coined by Laban, of 'movement sensations' does relate to the perceptual field of movement impressions, but little is made by Laban of the consequence of these sensory impressions or their artistic effect on the mind of the dancer. Nevertheless, humans experience the world as upright bipedal creatures and the vestibular functioning of the inner ear plays a crucial role in our sense of balance. The limbic system is known to integrate incoming signals from sound and movement with the functioning of balance and memory (Hannaford, 1995, p 73). In this respect, Laban's analysis of movement into objectively measurable and subjectively classifiable 'aspects' might be considered to be relevant to the bipedal nature of human movement and its integral relationship with the limbic system.

Like Laban, Jaques-Dalcroze (1921/1973) holds the view that the rhythmic and dynamic elements of movement may be placed in a framework of space and time. Through rhythmic training, described by Bachmann (1993), Jaques-Dalcroze sets about regulating the natural rhythms of the body and, through the automisation of carefully prepared rhythmic movement he hopes to create definite 'images' in the brain. These 'images' become automatic responses to specific musical signals. Through the action of rhythmic movement, Jaques-Dalcroze aims to train his pupils to develop rapid physical reactions to mental impressions.

Pre-empting the theories of Gardner and Dennison, Jaques-Dalcroze recognises that a link between physical aspects of bodily movement and cerebral behaviour probably exists. While Gardner (1973) links sensory impressions with emotional and aesthetic expression and Dennison (1989) links sensory impressions with cognitive clarity, Jaques-Dalcroze (1921/1973) links coordinated movements with concentration and imagination. However, Jaques-Dalcroze and Laban fundamentally disagree about the nature of rhythm and bodily movement. For Laban, music originates from the rhythmical movement of the body but for Jaques-Dalcroze, movement and dance are stimulated through musical rhythm. While for

Laban, expression emerges as rhythmical movement from a sense of the geometry of physical balance, for Jaques-Dalcroze, expression emerges from controlled coordination in motor responses to musical rhythms.

Rhythmic gestalts: intuitive knowledge

A search for a fundamental link between the rhythmic perception of words and music involves consideration of innate rhythmic pattern groupings. In a series of experiments, Vos (1973, pp 1-15) finds that metrical or periodically structured sequences are subjectively perceived as ‘accented’ and ‘grouped’ into patterns. The groups of tones are perceptually formed into units probably as a consequence of the gestalt laws of proximity and similarity. Differences in strength of the tones are perceived, although there are no differences in strength in physical terms. The subjects hear accents where there are none in actuality.

According to Vos, rhythmic perception is common to music and speech (Vos, 1973, pp 1-15). Molino (2001, p 165) suggests that poetry, rather than being a hybrid of language and music, constitutes the form of something that predates both language and music. Noting the relationship between music and language, Molino (2001, p 172) compares the articulation of syllables, the organisation of sentences and affective semantics with equivalent units in musical organisation. Similarly, rhythm is defined by Repp as a sequence of sounds, whether musical or non-musical, according to its divisibility into perceptual groups and tendency to temporal regularity (Repp, 2000, p 235).

The rhythmic patterns of Greek Metre are common to both the rhythmic patterns in music and in verse. In an experiment, Mursell (1971) examines the perceptual relationship between iambs and trochees of Greek Metre. He finds that when iambs are altered by shortening the time interval immediately after each strong beat, there is a moment that is indeterminate rhythmically and then a new pattern of trochees emerges from the sequence (1971, pp 170-171).

In his analysis of musical rhythm, Mursell states that ‘Takt’ underlies rhythm as the basic ‘mathematical’ beat; he explains that ‘Takt’ and the phrase rhythms together make up the rhythmic pattern. The rhythmic pattern is organised, held together and derives its character largely from ‘Takt’ (1971, p 191). In Javanese Gamalan music, ‘Takt’ is represented by a gong tone at the beginning of a cyclical pattern. Sometimes, ‘Takt’ is not heard but it is felt. In the Agbadza bell pattern of Ghanian music ‘Takt’ is a strong silent impulse at the start of the pattern. The mnemonic for the Ghanian Agbadza bell pattern is:

‘n ken-ken-ke-ken-ken-ken-ke’

in which, according to Kwami (1994, p 49) and Wiggins (1991, p 26), ‘n’ represents the stamped or felt impulse that probably translates into Mursell's idea of ‘Takt’ (1971, p 191). I suggest that ‘sensory impressions’ (Croce, 1900), created by the stamped impulses have, through prehistory, provided the frame or template for rhythmic gestalts that are described as ‘subjectively accented’ in experiments conducted by Vos (1973, p 15).

Cerebellar Regulation

Currently, neurologists believe that the cerebellum governs the control of eye-movements, balance, the skeletal-muscular system and possibly higher order functions as well. Bower (1997) and Bloedel and Bracha (1997) argue that the cerebellum coordinates new skills and new experiences from sensory data that is proprioceptive (meaning that it relates to kinaesthetic and tactile senses) and that movement and cognition are interdependent (1997, p 620). These findings might indicate some support for the basic tenant of the ‘Hierarchy of Knowledge’ in which Croce (1900) states that the acquisition of ‘conceptual knowledge’ is dependent upon previously acquired 'intuitive knowledge' and that the acquisition of 'intuitive knowledge' is dependent upon previously acquired 'sensory matter'.

A connection between physical movement and cognition is made by a psychologist, Trevarthen, who believes that a regulatory mechanism operates in music, movement and indeed, cognition. His studies of, a blind infant, reveal precise hand movements in response to music, even anticipating the melodic line as the mother sings (Trevarthen, 1999, p 190). Linking movement with the idea of a regulating system, Trevarthen (1999) then integrates these with the psychobiological source of music, claiming that intelligent perception, cognition and learning depend on music as a spontaneous, self regulating activity (Trevarthen, 1999, p 155).

Trevarthen describes a perceptual body-map that links physical kinaesthetic knowledge with body-centred time and space, whereas Paulin (1997) believes the cerebellum incorporates incoming data of the 'system's dynamics' in conjunction with the 'system's state'. This data, which includes information about body parts and the outside environment, is then coupled with an internal representation, or map, to ensure that there are appropriate modifications in behaviours that operate in response to the incoming data (Paulin, 1997, p 518). The functions described here present the cerebellum as the organ concerned with the adaptability of the 'system' to its internal and external environment.

The regulatory function of the cerebellum is described by Reis and Golanov (1997), who observe that the cerebellum regulates arterial pressure, heart rate and nerve discharge. The cerebellum also regulates cerebellar blood flow (ie, its own blood supply) according to cerebellar stimulation and independently of fluctuations in the organism's metabolic activity (Reis and Golanov, 1997). Accordingly, Schmahmann and Pandya (1997) find that the cerebellum regulates 'the rate, force, rhythm, and accuracy of movements' and 'possibly regulates the speed, capacity consistency, and appropriateness of mental or cognitive processes' (Reis and Golanov, 1997, p 55).

By drawing on Trevarthen's finding that music may act as a regulatory stimulus (1999) and the findings of the neurologists described above, it is possible to speculate that the cerebellum is directly involved in the regulation and organisation of body movement in response to musical or proto-musical stimulus. It is likely that rhythmic gestalts, generated by rhythmic body movement, are processed by the cerebellum as the regulatory organ. Neurological links between the cerebellum and elements of the higher areas of cognitive function such as: 'speed, capacity and rhythm' described by Schmahmann and Pandya (1997, p55) may provide the means by which rhythmic body movement may assist the temporal aspects of reading and also by which Croce's 'sensory matter' (1900) may indeed become the necessary component for the acquisition of 'intuitive' and 'conceptual' knowledge.

In experimental work by Leiner, Leiner, and Dow (1987; 1989; 1991; 1993), studies by Schmahmann and Pandya (1992), Schmahmann and Pandya (1997), Jones (1985) and Middleton and Strick (1997), findings show that the human cerebellum is connected to the cerebral cortex in such a way that allows the communication of symbolic messages between the cerebellar and cerebral cortices by means of nerve fibres that are segregated into distinct bundles. Middleton and Strick (1997), Schmahmann and Pandya (1997) have established that, in humans and apes, an area of the cerebellum called the dentate nucleus increased in size in parallel with and is connected to the frontal, parietal and temporal lobes of the brain. The dentate nucleus projects beyond the motor cortex to areas that are to do with higher cognitive function: conjugate eye-movements, planning, decision-making, foresight and judgment, as well as proto-language functions (Schmahmann and Pandya, 1997, pp 42 and 50). It is likely that the development of the dentate nucleus followed an evolutionary period of adaptation and cerebellar regulation in response to specific stimulus conditions that were experienced or induced through typical behaviours among hominids of that era.

Temporal Regulation

By focusing on issues to do with timing in the brain, it may become possible to find evidence of a temporal relationship between specific physical movements and higher cognitive functions: language use, planning, judgment and conjugate eye-movements.

Poppel (1997) cites experimental work with brain-damaged patients in which findings suggest that the two frontal lobes connected to the dentate nucleus of the cerebellum perform reciprocal work in a dynamic pull-push relationship. This allows integration of temporal processing to be stabilised and the regulation of successive temporal intervals (Poppel, 1997, p 58). Both of these functions are likely to be intrinsic to the formation of rhythmic gestalts within the subjective perception of ‘continuous’ time.

In recent years a number of studies have established that timing in the brain is constructed on two levels that are interlinked, so that a subjective perception of time as a continuum is achieved. In a paper entitled ‘The Reconstruction of Subjective Time,’ Poppel (1996, p 166) states that the ‘traditional view’ held by psychophysicists regarding subjective time as a continuum is actually incorrect. Poppel goes on to explain that an illusion of the continuity of time is perceived because temporal processing is sampled from two independent processing systems that are hierarchically linked with one another.

Studies of high-frequency temporal processing from evidence derived from temporal order thresholds (Block, 1990; Fraisse, 1984; Poppel, 1978; 1997; Wittmann and Poppel, 1999) suggest the activity of a ‘central timer’ (Wittmann and Poppel, 1999, p 16). The findings in the studies discussed provide evidence showing that in motor tasks, temporal processing occurs in steps of 30ms (Wittmann and Poppel, 1999, p 16). These results were produced from studies of pursuit eye movements (Poppel and Logothetis, 1986) and finger-tapping studies (Ascharsleben and Prinz, 1995). The studies, whether of motor tasks, finger-tapping or pursuit eye movements, all revealed a motor response every 30ms despite the multi-modalities mentioned in all of these studies. The authors conclude that this may be explained by a central timer that operates with a frequency of approximately 30 Hertz (Hz), initiating a motor response every 30 milliseconds (ms) (Poppel, 1997). In conclusion, Repp describes this phenomenon as a level of highly accurate temporal perception that sub- serves motor control and precedes the level of conscious perception and judgment (Repp, 2000, p 139).

A model of temporal processing proposed by Irvy (1996) suggests an interval-based system in which different time intervals are represented by their respective and distinct neural assemblies and are located in the cerebellum. In addition, Irvy (1996) suggests that these might be described as a ‘Common Timing Mechanism’. In the findings of finger-tapping tests, Irvy (1993) recognised that while both motor control and temporal perception shared a ‘Common Timing Mechanism’, these two functions were associated with different regions of the cerebellum (Irvy, 1993, p 217).

A second timing mechanism that identifies a perceptual sense of the ‘present’ is examined in Wittman and Poppel (1999). A theoretical framework, involving a ‘psychological present of three seconds duration’ has been set out by Fraisse (1984). A study by Schleidt *et al.* (1987) shows a sector of motor movement in humans typically conforming to the universal temporal constant of about 3 seconds duration. A study by Gerstner and Fazio (1995) demonstrates that the typical vigilant behaviour stance of different mammalian species also conforms to the temporal constant of 3 seconds suggesting that this temporal mechanism is not exclusive to human behaviour. The authors note that dopamine is excreted by the basal ganglia at 3 second intervals and that this may be a temporal influence on behaviour patterns. An earlier paper by Irvy and Keele (1989) cites two studies that support these findings. Both these studies involve Parkinson's disease patients, where the main neurological damage is in the neural pathway between the production of dopamine and the basal ganglia and revealed a timing deficit. The patients show difficulty in producing regularly timed intervals (Wing, Keele and Margolin, 1984; Keele, Manchester and Rafal, 1985). Wittmann and Poppel (1999) demonstrates empirical evidence that shows that both perception and motor behaviour in humans are segmented into units of up to 3 seconds. This perceptual unit of time is described by the authors as a 'critical time window' (Wittman and Poppel, 1999, p 20).

Two models (Szelag, von Steinbuchel, Reiser, de Langen, and Poppel, 1996; Fraisse, 1978) that examine the effect of rhythmic gestalt on the perception of time are presented by Poppel and Wittmann (1999). The findings in these studies show that metrical beats are perceived as units of integrated beats with a slightly lengthened beat at the start of each unit. The units may lengthen at lower metronome frequencies (slower beats) but the units will never lengthen beyond 3 seconds. The paper describes these automatic temporal integrations of individual beats as 'rhythmic gestalts'.

Studies cited in Irvy and Keele (1989) demonstrate that the cerebellum is a predictive device, enabling the accurate timing typical of the rhythmic tapping tests and the conditioned eye-blink experiments by Thompson, Clark, Donegan, Lavond, Madden, Mamounas, Mauk, and McCormick, D. (1984) and Yeo, Hardiman, and Glickstein, (1985a; 1985b). The cerebellum and the basal ganglia are connected to the frontal lobe where planning the order and timing of future behaviours occurs (Middleton and Strick, 1994, pp 458-461). The Middleton and Strick study (1994) links the control of motor movement, the ordering of thought and the planning and timing of future events with the cerebellum, the basal ganglia and the frontal lobes. Irvy concludes that the cerebellum may operate over a relatively short temporal window and that 'timing functions of the basal ganglia are utilized in tasks spanning longer durations' (1996, p 855).

The aesthetic judgments of time in music, poetry and conversation, while infinitely flexible, are always performed within the parameters of rhythmic gestalt if they are to convey intelligible meanings. Turner and Poppel (1988) assess the temporal constraints in poetry, spoken in different languages, and find that each line of verse was recited in around 3 seconds. Findings from Wingfield and Nolan (1980) confirm that information processing in normal speech is segmented into 3 second intervals, revealing integration units that closely resemble the metronome experiments (Szelag *et al.,* 1996; Fraisse, 1978).

A study by Schleidt and Klein (1997) showed that action units, measuring the temporal duration of lasting movements that make up behaviour, vary between species. Most action units fall between 1-4 seconds in human behaviour. Baboon action units are shortest in duration, those of chimpanzees are medium in duration and human action units are the longest in duration. The differences are thought to be directly related to the capacity of the short term memory.

Findings from the Schleidt and Klein (1997) study challenge the claim made by Gerstner and Fazio (1995) that mammalian vigilant behaviour conforms to a temporal and 'universal' constant of 3 seconds. I suggest that there may be a distinction to be drawn between instinctive and intentional behaviour and that the temporal aspects of intentional and instinctive behaviour will not correspond. The findings of the Gerstner and Fazio (1995) study appear to be appropriate to instinctive behaviour; whereas the results of the Schleidt and Klein (1997) study might indicate that intentional behaviour is regulated by a more species-specific level of temporal organisation. The discussion that follows is concerned with intentional, rhythmic behaviour and evidence suggesting that this has played a part in the development of particular reflexes and rhythmic gestalts.

Balance and Spatial Perception: The cochlea

The optic nerve, the oculomotor nerve and the various nerves that are associated with movement, channel through the vestibular labyrinth of the cochlea, which is a part of the inner-ear complex. The acoustic nerve travels from the cochlea to the brain. The sense of motion associated specifically with the perception of music via the cochlea, is examined by Todd (1999), Bickford, Jacobson and Cody (1964), Townsend and Cody (1971), and Wilson and Peterson (1981).

According to Todd (1999), there are probably two distinct sensory-motor mechanisms that offer two forms of modality. He suggests that both of these neuropsychological mechanisms interact between the sensory-motor system and a sensory system. The first of these Todd (1999) describes as an audio-visual-motor mechanism (which combines the temporal and spatial filters, or receptive fields, with their respective frequencies) which is elaborated by Todd as 'high-level, indirect and a product of learning' (Todd, 1999, p 116). The second mechanism that Todd refers to is a vestibularmotor mechanism (to do with balance and therefore bi-pedalism) which, he suggests, functions as 'low-level, direct and reflexive' (Todd, 1999, p 116). By examining this vestibularmotor mechanism, Todd seems to imply that a basic sense of motion, perceived through musical sounds, may stimulate automatic responses that imitate locomotion. A theory is set out by Todd *et al*. (1999) in which, a feed forward system that represents the movements of the musculosceletal system, is portrayed as a dynamic model. This system mediates beat induction by blending the information from the feed forward system with low-level sound signals and then instructs the 'body' to synchronise its movements with the beat. The importance of rhythm in bipedal locomotion in this system is discussed by Todd *et al.* (1999), not in terms of impact and pressure, but rather as a component of the physiology and the velocity of walking and running. The model proved unsuccessful, possibly because the researchers opted to incorporate the physiology of running and walking into the model rather than the physiology of rhythmic stamping. I suggest that the cultural legacy of stamping patterns, for example, from primitive rites and rituals, are more likely to have influenced music and linguistic temporal patterns than the physiology of walking and running.

Automatic locomotive responses to music are demonstrated by Harrer and Harrer (1977). Findings demonstrate that an increase in impulses in the leg musculature is recorded while the subjects sit and listen to dance music. This reflexive effect of dance music has also been described by Wallin as:

> …reflection of a violent acoustical precursor to music as the initiator of the activities preceding dance' [that] 'influences the mid brain command neurons of the early bipedal man by inducing an 'acoustical nystagmus' via the vestibulary organ, phylogenetically in coupling with the cochlea organ and sensitive to impulsive stimuli ... the strong coordination between the musical temporal parameters (duration, accent, pitch) and the movement of limbs, trunk, head and eyes - in their turn all correlated - indicates that the music has released a dynamic coupling of physiological, motoric and perceptual functions'. (Wallin, 1991, p 287)

In addition Brown, Merker and Wallin (2001, p 12) claim that the ability of humans to entrain themselves rhythmically to an external rhythmic source, such as a drum, is a species-specific trait. This statement is offered for discussion in studies by Geissmann (2001), Merker (1999) and Kohler (1973).

Comparing Apes and Humans

According to Kohler, chimpanzees display bipedal locomotion as a source of rhythmic regulation for the synchronisation of the social group (Kohler, 1973, pp 326-327). Synchronised calling in the 'Carnival Display' of chimpanzees, recorded by Merker (1999) shows chimpanzees maintaining a steady collective rhythm through body movement. It is thought that humans of the late Micene period onwards displayed the behaviour of female exogamy that is demonstrated by chimpanzees today (Ember, 1978).

According to Merker (1999, p 62), the territorial behaviour of the Miocene males was probably similar to the chimpanzee males of the territorial group. Males of the Micene period would typically remain in their 'natal territory' and display synchronous chorusing of a similar nature to chimpanzees. It is likely that this synchronised mating call may have been supported by bodily movements that help to steady the collectively felt rhythm as a form of sexual enticement for migratory female groups (Merker, 1999, p 65). According to Merker (1999, p 65), it is likely that the Micene females would have been more sexually attracted to the males among the chorusing group with the most pronounced upright posture and particularly those with notably refined bipedal locomotion. Sexual selection of this sort would probably have reinforced the achievement of bipedal locomotion and upright posture in the evolution of Micene man.

Human music is claimed by Geissmann (2001) to have been inherited from the 'Loud Calls' of many 'Old World' primates and that this ancestral link through music may account for the universally hypnotic affect that music has on humans. 'Loud Calls' consist of a rhythmic series of long notes that increase in tempo as they progress (2001, p 118). A sequence of this type may be repeated many times in a song. The ritualized locomotor displays that accompany 'Loud Calls' involve drumming, stomping and branch shaking in species such as *Cerocebus galeritus, Macaca silenus, Trachypithecus johuii* (Vogel, 1973; Horwich, 1976; Tilson and Tenaza, 1976; Tilson, 1977; Byrne, 1981; Waser, 1982; Herzog and Hohmann, 1984; Steenbeck and Assink, 1998). There are about 26 species of singing primates constituting 11% of primate species and 6% of primate genera. Research on the anatomy of rhesus monkeys, conducted by Schmahmann and Pandya (1997), has revealed that, as in humans, there is an organised and consistent projection from the prefrontal cortex to the input system of the cerebellar circuit. The functions of the prefrontal-cortex in humans and apes are thought to be very important in the normal integration of higher order behaviour. This development may be linked to the ability to synchronise rhythmic movements and 'Loud Calls' in these species.

The advantages of keeping a steady beat whilst singing as a group are that well-coordinated group cohesion is likely to promote a more effective and impressive display, to encourage courtship within the group and to deter predators from outside the group (Geissmann, 2001, p 119). Findings by Kohler (1973), Merker (1999) and Geissmann (2001) suggest that some primates are able to entrain themselves rhythmically to a collectively felt beat. These findings disprove the claim made by Brown, Merker and Wallin (2001, p 12) that the ability of humans to entrain themselves rhythmically to an external beat is a species specific trait. Unfortunately, Geissmann does not specify to what extent, if any, the arboreal style of locomotion that the gibbons have developed is bipedal and therefore this study is of limited relevance to the Merker (1999) argument. However, Geissmann does refer to results of studies showing that the songs that hybrid gibbons sing are not learned from their parents and this finding indicates that an inherited component exists in gibbon song repertoire (Geissmann, 2001, p 110).

Dances: gestalt formation

While the 'violent precursor' to music and to dance described by Wallin (1991, p 287) may well correspond with Sachs' (1937) description of 'convulsive dances' as 'paroxysms of contortion and trancelike frenzy', 'harmonious dances' are associated with joyful and pleasurable dancing. The dancers work in accord with their bodies as they coordinate all of the movements that they use into the regulating rhythmic impulses of the dance. The recreative imitation of animal movements in 'harmonious dances' suggests a clear indication that there is an 'intentional' as opposed to an 'instinctive' link between motor control, timing and the ordering of thought at this stage of cultural development.

The 'Return Dance' is a type of 'harmonious dance'. As its name indicates, the danced steps move away from the starting place and then return to the starting place again. The most characteristic feature of the 'Return Dance' is that it comprises of only a few steps. Any tension that arises in the form of this dance is resolved and any contracted muscle is relaxed. There is a constant ebbing and flowing of nervous energy that always returns to the state of a restful norm. The rhythmical swing is almost like breathing. The backward and forward movement of the body matches the tension and release that is reflected in the musical structure of the 'Return Dance'. The tribes that typically practice 'Return Dances' are of early planter cultures. They prefer symmetrical arrangements and dance steps that are arranged in multiples of two.

A small part of the practice of cyclical music making in agrarian cultures, such as those of the early planter cultures, includes a tradition of formally ending a piece of music by repeating a rhythmic pattern three times. In North Indian classical music, 'Tintal' is the most common tal. In 'Tintal,' the traditional practice of repeating a rhythmic pattern three times is known as 'Tihai' (Farrell, 1990, p 68). Similarly, in Ghana a tradition of formally ending a piece of music in this way also exists (Kwami, 1994). Accounts of dances from antiquity, right up to the folk dances that have survived to the present, feature the repetition of a pattern three times such as the Tripedium dance of the Salii, warriors and priests of Mars, who stamped 'like fullers' in repetends of three beats (Sachs, 1937, p 246). I suggest that the precise practice of specific rhythmical patterns grouped in arrangements that are symmetrical or of aesthetically structural significance is likely to provide evidence of species specific behaviour among humans.

Succession: conceptual knowledge

By combining the binary properties of the 'Return Dances' with a model constructed from Croce's 'Hierarchy of Knowledge', it may be possible to suggest the following:

- symmetrical and binary patterns of Return Dances are classified as *'sensory matter'*;
- the binary symmetrical gestalt patterns characteristic of so many artefacts of aesthetic value might be classified as '*intuitive knowledge'*;
- the acquisition of mathematical ideas may be classified as *'conceptual knowledge'*. The following description of theoretical succession by Husserl may encapsulate a form of *'conceptual knowledge'* perhaps generated originally by the 'Return Dance':

> 'Let us suppose that A appears as a primal impression and endures for a while, and along with the retention of A in a certain level of development B appears and is constituted as enduring B. Therewith, during these 'processes', consciousness is conscious of the same A moving 'back into the past,' the same A in the flux of these modes of giveness, and the same according to the 'duration' belonging to

the form of being appropriate to its content according to all points of this duration. The same is true of B and the difference of both durations or their temporal points. In addition to the above, however, something new enters here: B follows A. There is a succession of two continuing sets of data given with a determinate temporal form, a temporal interval which encompasses the succession' (Husserl, 1966, p 65).

This description, I wish to suggest, encapsulates that part of the reading process that requires one idea to be held in the mind as a semantic unit while the reader progresses to the next semantic unit and then accommodates the units to extract meaning from them and indeed from the text.

Summary

Perhaps the symmetrical rhythmical patterns of the 'Return Dances' that were preserved and danced precisely across generations have enabled the symmetrical transformations that are found in the classification of rhythmic perception. According to Jaques-Dalcroze, the use of the term 'foot' to describe the rhythmic unit in Greek metre is common to most modern languages. The term suggests an association between the rhythmic patterns and bipedal movement. This, says Jaques-Dalcroze (1921/1973, p 96), is not a coincidence but rather an indication of the Greek understanding of rhythm and its origins in movement. Moreover Jaques-Dalcroze prefers not to disassociate the rhythms of speech and music as he believes that natural rhythmic laws are common to verbal, instrumental and vocal rhythms (1921/1973, p 68).

The placing of bodily movement into a spatial-temporal framework is common to each of the theories of Gardner, Jaques-Dalcroze and Laban. The conveyance of sensory information into a spatial-temporal framework is described by Gardner (1973) as the function of a 'preverbal modal-vectoral chord' where modes are space oriented and vectors are time oriented. Similarly, Jaques-Dalcroze describes the movement of the body as requiring a 'quantum of space and a quantum of time' (1921/1973, p 37). However, Laban (1973) also describes the dimension of impact in bodily movement, as he refers to the elements of time-rhythm in association with the elements of weight-rhythm and in so doing brings the accented and unaccented parts of movement sequences into relief. Like Gardner, Jaques-Dalcroze recognises that a hierarchical progression from sensory impressions to the formation of mental 'images' to an enriched imagination may exist. Indeed he speculates that stronger muscular movements would produce stronger mental images and an even more vivid imagination (1921/1973, p 68). Each of these theoretical perspectives may be placed in the context of Croce's 'Hierarchy of Knowledge' (1900) in which the acquisition of 'conceptual knowledge' is preceded by the acquisition of 'intuitive knowledge', which is preceded by the acquisition of 'sensory matter'.

I suggest, firstly, that the repetition of specific rhythmical patterns across generations of ritual and dance may correspond with the regulating framework that is recognised as the source of the 'intrinsic motive impulse' described by Trevarthen (1999). Secondly, I suggest that the neural networks of the cerebellum, described by Bower (1997), Bloedel and Bracha (1997), Paulin (1997), Schmahann and Pandya (1997), are likely to function as a temporal regulatory mechanism that may have developed partly through the influence of carefully preserved rituals and dances. During the precise practice of these rituals over many generations, I suggest that these regulating mechanisms were continually reinforced to create a possible ancient learning pathway linking the regulating aspects of rhythmic movement with the regulation of the acquisition of intuitive and conceptual knowledge. Thirdly, I suggest that the actual rhythmic and structural patterns of ancient and traditional rituals and dances are likely to correspond directly with the gestalt patterns, described by Kwami (1994), Farrell (1990) and Sachs (1937) of Greek metre described by Molino (2001) and in findings of experiments conducted by Vos (1973).

The regulatory relationship between rhythmic movement and higher cognitive function may further explain the basic tenets set out in the 'Brain Gym' system (Dennison and Dennison, 1989) and also add a regulatory aspect to the understanding that already exists with respect to movement and learning via the natural meridians of the body. In the 'Hierarchy of Knowledge' Croce (1900) sets out three nested levels of knowledge acquisition. I suggest that between each level of the hierarchy, a process of spatial-temporal regulation, probably controlled by the cerebellum, enables the acquisition of knowledge by the subsequent level in the nested model. Difficulties experienced by schoolchildren in reading and learning may be partially or completely resolved through a rhythmic movement programme. I suggest this movement programme will focus in particular on stamping, clapping and chanting actions, thereby perhaps reactivating the proposed ancient learning pathway. The regulatory aspects of the cerebellum and the nested aspects of the model: 'Hierarchy of Knowledge' (Croce, 1900) might also be theoretically confirmed through this intervention programme.

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