

A BEHAVIORAL CYBERNETIC INTERPRETATION
OF DANCE AND DANCE CULTURE

BY

FRANK WHITE HATCH

A thesis submitted to the Graduate School
of the University of Wisconsin in
partial fulfillment of the requirements for the degree of

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A BEHAVIORAL CYBERNETIC INTERPRETATION OF

DANCE AND DANCE CULTURE

Frank W.^{HITE} Hatch

Under the Supervision of Professors Karl U. Smith
and Louise Kloepper

This descriptive study consists of a systems analysis of dance and dance culture. A feedback theory of self-governed behavior is used to describe the dancer as a dynamic control system. Highly coordinated interactions of dancers with each other and with their audience are explained in terms of mutual social tracking, wherein the motorsensory systems of two or more persons are cross-yoked with each other in dynamic acts of mutually controlled behavior.

A cybernetic theory of cultural behavior is applied to the symbolic movement of dance to show how dance acts as a control factor of cultural expression and communication. An evolutionary summary and interpretation of dance history is presented as evidence for the systems or cybernetic interpretation of dance. This summary explains why older levels of dance behavior persist and coexist with newer developments to form a living record of culture.

Approved

Karl U. Smith
Louise Kloepper
Ellen A. Moore

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Special recognition is given to Linda V. Hatch whose performance in this production has ranged in depth and width in the roles of wife, mother, typist and professional partner. Her strength and capabilities have made the mechanics of this work possible.

CHAPTER I

INTRODUCTION

This thesis is concerned with the understanding of dance behavior as a behaviorally controlled systems integrated process of individual and cultural adaptation. More specifically, this theoretical study is intended to formulate a concept of dance activity based on a behavioral cybernetic approach which it is hoped will have relevance to all forms of dance as performance activity and to the study of dance. The term "behavioral cybernetic approach" refers to the use of feedback and systems concepts to account for the relations and interactions between dance performance and physiological, social cultural, educational and evolutionary processes.

The proposed theory states that dance is a specialized form of guided and controlled behavior and that the dancer and dance group always perform as self-controlled and self-integrated systems. The essence of dance and the art surrounding it is self-guided skill and discipline in utilizing a special cultural syntax of body and movement-language to convey both social and physiological meanings. In this theory styles, forms and expressive characteristics of dance behavior are accounted for in terms of feedback-controlled motorsensory activities that transform and extend control of the internal and external environment through instrumental or symbolic behavior. Among the primary adaptive functions of dance and language, that of spanning time to

enhance social memory is probably the most significant. In the view to be presented, the dances of the people of the world represent a living, persisting record of the evolutionary and progressive development of feedback-controlled motorsensory transformations essential to bringing certain aspects of psychological timing to a culture. By virtue of organic interactivities, dance behavior also functions as one phase of behaviorally controlled bio-energy production that can be integrated within varying cultural contexts. One of the functions of dance in a Paleolithic or tribal society is the physical and psychological preparation for hunting or war. In modern society the most important function of dancing may be its value in inducing physical fitness for healthful living.

This paper is an effort to extend existing theoretical accounts of dance activity to encompass better specification of the control features of such behavior. With the exception of H'Doubler's (1940, 1925) and Martin's (1939) writings on this subject, dance theorists have been limited in dealing with fundamental questions of the way in which the dancer organizes and controls individual and group actions in creative behavior, energy production, motivation, evaluation and the selection of symbolic expressive motion. The aim here is to clarify these properties of the dancer and the dance group as controlled, guided and timed systems.

HISTORICAL SURVEY OF DANCE THEORY

Past Theories

Some of the earliest records of man portray evidence of coordinate social activity equivalent to dancing and speculate on how benefit derives from its practice (Lawler, 1964). Proto-historic records including the Natya Sastra allegedly communicated to the sage Bharata Muni by Brahma (Zarina, 1967) and Plato's Republic (Jowitt, 1888) praise it in general for its fundamental religious and educational functions. Both the ancient Indians and the Greeks attributed the origins of dance to supernatural creation and their theories about its value and meaning were often mixtures of mystical and rational explanations and descriptions of prescribed movement patterns.

The Natya Sastra still stands as the basic text and theoretical treatise for Indian dance. Not only does it give all the rules, postures, and gestures for human expression through the dance but it theorizes upon the aesthetic and spiritual implications of all the dance patterns it prescribes. In the Natya Sastra it is written that the art of the dance brings fame, prosperity, happiness, and knowledge. It makes one liberal, generous, steady, and enlightened. It wards off misery, covetousness, and jealousy (Zarina, 1967). Bharata held these benefits to be self-evident and explained that if it were not so, the gods and divine sages would not have been attracted to it.

In Western culture the Pythagoreans championed life-long rhythmic exercise activities on the grounds that they were essential to a balance between "mind" and body (Hale, 1969). Plato (Rogers, 1941) in the Laws maintained that "A good education consists in knowing how to sing and dance well." In the Republic (Jowett, 1888) however, he points out that at sixteen the individual practice of music and dance should cease and give way to the more lofty purpose of "instruction to the mind" Plato's rationale for dance education, "music and gymnastics" as he often called the activity, was that a harmony between bodily parts and "a natural order and government of one by another in the parts of the body" resulted. These understandably general rationales for dance activity have stood as models for subsequent efforts to describe and justify the dancing arts and their role in education in Western civilization. While ancient writers on the dance often asserted that its practice was beneficial and even essential to achieve a balanced personality (Lawler, 1964), it appears that no explanations of the mechanics of this benefit were given. To these people who universally practiced dance its values and significance were no doubt self-evident and taken for granted.

The sixteenth century French scholar Thoinot Arbeau (1967) explained that:

Dancing, or saltation, is both pleasant and a profitable art which confers and preserves health proper to youth, agreeable to the old and suitable to all . . .

This statement follows in the tradition of earlier writers in that dancing was held to be not only pleasant but also profitable to the

well-being of the dancer. Arbeau further pointed out that dancing was valuable in the process of selecting a mate since:

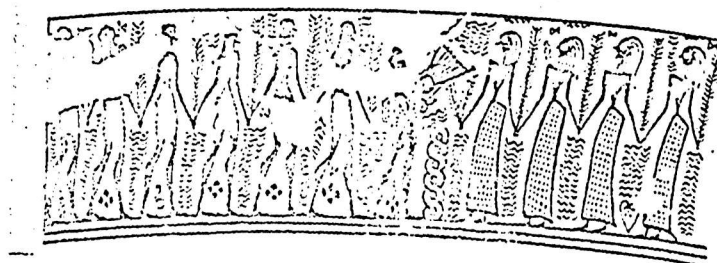
Dancing is practised to reveal whether lovers are in good health and sound of limb, after which they are permitted to kiss their mistresses in order that they may touch and savour one another, thus to ascertain if they are shapely or emit an unpleasant odour as of bad meat. Therefore, from this standpoint, quite apart from the many other advantages to be derived from dancing, it becomes an essential in a well ordered society.

Arbeau then proceeded to describe the pre-classic dance forms of his time in great detail, apparently assuming that the rigors of the dances obviated the "advantages to be derived" from their practice.

Much later Jacques-Dalcroze (1935) also returned to Plato's theme in describing the value of dance activities:

I am certain of one thing: that the rightly-directed will convert mean and selfish instincts into generous and altruistic ones . . . the function of parents and teachers is to strengthen and develop the child in such fashion that the mind and body form a perfect instrument wherein to learn to play the song of life. . . . It was my teachers' classes that showed me the manifest power of rhythmic gymnastics in transforming the mind along the lines of greater self-possession, stronger power of imagination and more constant mental concentration.

It is seen here that Jacques-Dalcroze clearly recognized the values of dance activities. His writings and life's work reflected a clear understanding of the importance of rhythmic movement activities such as dance to the education process. Nevertheless, Dalcroze's writings fall short of explaining the mechanisms of behavior that make it possible for dance activities to transform the mind to "self-possession," "imagination" and "concentration."



Mycenaean dance scene



Thai temple dance

Reuerence



Court dance

Figure 1

Examples of historic dances

In this same vein, G. Stanley Hall (1904) has stated that:

Right dancing can cadence the very soul, give nervous poise and control, bring harmony between basal and finer muscles, and also between feeling and intellect, body and mind. It can serve as an awakener and a test of intelligence, predispose the heart against vice, and turn the springs of character toward virtue . . .

Modern Theories of Dance Activity

A quantitative analysis of recent literature devoted to the theory of dance reveals that dance theorists have turned to more concrete descriptions of dance form and content in an effort to explain its objective and subjective nature (Ellfeldt, 1967; Murray, 1953; Humphrey, 1951; Hayes, 1964; Laban, 1951). While this literature describes various theories of the factors of space, time and force in emotional, dramatic and abstract expression, it fails to deal directly with the questions of how the dancer organizes and guides the behavior that results in objective and subjective components of dance. The nearest approach to such an objective-subjective analysis was made by Sheets (1963) who attempted to develop a holistic treatment of these components by applying the existential methodology of phenomenology to a description of dance and its role in education. In her explanation of dance, Sheets pointed out that temporal and spatial structures of dance are not discrete functions but rather comprise a part of the "lived experience" that characterizes dancing. She further subscribed to Langer's (1953) theories that hold that art represents an illusion of reality by means of symbolization. In this theory of dance the objective elements of space, time, and force were believed to be

organized systematically to represent or symbolize the subjective elements of actual human feelings or emotions. The strength of such a theory lies in its effort to account for the continuous and ongoing nature of all human experience. Nevertheless this theory stops short of attempting to explain the human factors involved in the control of either the objective or subjective elements manifest in dance behavior.

Martin (1939) and H'Doubler (1940) have tried to describe the workings of a dancer in the process of dancing. Martin gave a description of kinesthesia that could be roughly termed a motor theory of perception. He stated, "All our perceptions are matters of motor reactions. Otherwise they would not be perceptions at all, but mere sensations." Martin held that movement was communicated through the kinesthetic sense. He maintained that "we are made aware of any object only in terms of the appropriate movement we are prepared to make with relation to it." Furthermore, Martin indicated that the dancer's whole function was to lead his audience into imitating his actions with their faculty for inner mimicry. According to Martin, motor responses were registered by movement-sense receptors which awakened appropriate emotional associations in the onlooker that were similar to the emotions that motivated the dancer in the first place. He held that all dance was essentially the externalization of inner, emotional force in terms of bodily movement.

It is clear in his theoretical statements about the means whereby the dancer determined the form and content of his dance that Martin was strongly influenced by a concept of central or internal

motivation. He often referred to an "innerman" supplying the drives and motivations to be executed by an "outward body" within which the "innerman" was tucked. While Martin's thinking in this area was obviously influenced by the stimulus-response concept of behavior that was prevalent at the time he wrote, i.e. theories of reinforcement through internal drive reduction (Hull, 1943; Skinner, 1938; Watson, 1924), his ideas on the interaction that took place between the dancer and his audience were quite similar to a systems theory of reciprocal interaction. He pointed out that while watching dancing an individual ceased to be a mere spectator and became a participant in the movement by "dancing synthetically" with his own musculature. Martin's theories did not go all the way in defining dance as a feedback controlled activity, but they succeeded where other theories failed in presenting an intuitively accurate explanation of the dance act that has stood as a standard explanation and rationale of dance for both the dancer and the general public.

H'Doubler (1940) succeeded in most clearly developing a descriptive theory of how the dancer behaves. She believed that dance should base its movement forms on the laws of bodily motion and that the study of dance must consist basically of gaining an understanding of those laws. H'Doubler's theory of dance behavior was that the "mind," which she designated as the mental aspect of the total organism, organized and controlled the "neuromuscular setup as a behavior equipment possessing reflex paths . . ." She explained that:

The process whereby man gathers unto himself experience and performs acts manifesting sensation, choice, and volition,

is accomplished through the nervous system by means of its stimulus-response mechanism.

H'Doubler conceived of the process in which the dancer received stimulation from internal and external sources and molded them into the art act as a chain of events that begin with receiving organs or receptors that picked up information from the outside world and from the milieu interieur. The mass of sensory material, in her view, was then processed by the "old brain" or thalamus after which it arrived at the cerebral cortex where it became organized into definite images and ideas about the environment. Thereafter, the information was thought to be passed on to the effectors for motor execution.

These ideas of the mechanisms of dance behavior are parallel to and very likely based on the stimulus-response and operant conditioning theories that were coming into vogue at approximately the time that H'Doubler developed her theories of dance (Thorndike, 1913; Watson, 1924; Skinner, 1935; Hull, 1943). Despite the fact that her theoretical writings grew out of the unproven concepts of behavior represented by stimulus-response and behaviorism theories, H'Doubler's work stands as the single most influential explanation and theory of dance and its educational role (Shawn, 1951). H'Doubler's insight and intuitive understanding of the workings of a dancer in self-governed expressive behavior made it possible for her to develop techniques for teaching dance and for explaining its process in a manner that transcended much of the erroneous and incomplete information about the psychology, neurology and physiology of behavior that was available to her. Mixed in with her stimulus-response oriented explanations were

such statements as "movement becomes dance when the feelings aroused by movement are the reason for moving" and "To gain . . . discrimination, one must give attention to muscular sensations." These statements in her writings and her continuous references in the classroom to the importance of kinesthetic feedback in controlling dance movement point to her basic intuition of the concepts underlying a feedback controlled systems explanation of behavior.¹

Past theories of dance need to be made more specific as to the human factors and mechanisms involved in both the control and organization of dance activity at the individual social and cultural levels. Kealiinohomoku (1969) has aptly pointed out that dance has not even been defined to date in a way that accounts for its multivariant manifestations in the world nor is there, so far, a body of theory which has been developed to deal with all dance forms as a general activity of mankind. In an effort to contribute to a fundamental theory of how man organizes and controls his movement in dance behavior, this descriptive study applies the basic tenets of the feedback theory of behavior to self-governed movement in dance activities. The various modes of social interaction associated with dance are described in terms of closed feedback interplay between persons. A behavioral cybernetic interpretation of dance as non-verbal language or instrumental behavior is explained. Based on these concepts a theoretical

¹In 1971, Miss H'Doubler expressed to the writer that she thought the field of Cybernetics was turning out to substantiate the ideas that she was trying to express in the area of dance education. (H'Doubler, 1971).

approach to dance history as an evolutionary record of the levels of cultural development related to time perception is developed and presented.

CHAPTER II

DANCERS AS A CONTROL SYSTEM

The salient fact about dance is that it is a specialized form of motion. In order to understand dance in terms of motion it is necessary to understand the mechanisms whereby the dancer moves. Dating as far back as the time of Greek science, numerous theories have been proposed about the determination of motion. These theories have varied from assumptions of mental control, association, physiological drive states, gestalt theory, stimulus-response through contiguity or reinforcement and more recently, the behavioral cybernetic theory of behavior.

Recent developments in the fields of behavioral cybernetics (Smith, 1971), physiology (Hubel, 1963; Mountcastle, et al., 1968) and biology (Cooper, 1971) support the validity of the theory of human motion as described by behavioral cybernetics. The crux of these developments is that behavior is both controlled and organized as continuously controlled feedback processes of motorsensory, motor-physiological and sensory-neural interactions. As applied to human motion, and in particular to dance behavior, the concept of feedback implies self-regulated behavior. In contrast, past psychological views have tried to explain motion as sequences of discrete reactions, or in a causative sense, as discrete products of environmental stimuli. Stated as a general theory, the feedback concept states that living

systems are self-regulating in all their aspects and that characteristics of their performance and learning result from closed-loop feedback control within the system itself. The view implies a special experimental methodology for the study of motion in that behavior must be analyzed in terms of functional relationships between dynamic response and sensing and physiological processes which constitute its integrated whole. This approach to the study of human behavior has been called behavioral cybernetics (Smith, 1971) and it provides the basis upon which a new systems theory of dance and dance education can be founded.

Feedback Control

The main objective of this section is to describe how an individual dancer organizes and guides his own movement patterns in terms of the behavioral cybernetic concept of feedback control (Smith, 1971). The word feedback, in this context, means the continuous reciprocal interaction between motor function and sensory input, as mediated by neural processes (Fig. 2).

Figure 2 illustrates a simple model of a closed feedback system and contrasts it with a model depicting the opposing stimulus-response explanation or behavior. While in the S-R model the response is dependent upon discrete stimulus events, the closed feedback model points out that stimulation and response are mutually interdependent. Not only is response dependent continuously upon sensory input at the receptor but sensory input is directly and continuously dependent upon effector action of the motor system. Such an arrangement is commonly termed a closed-loop system (Fig. 2).

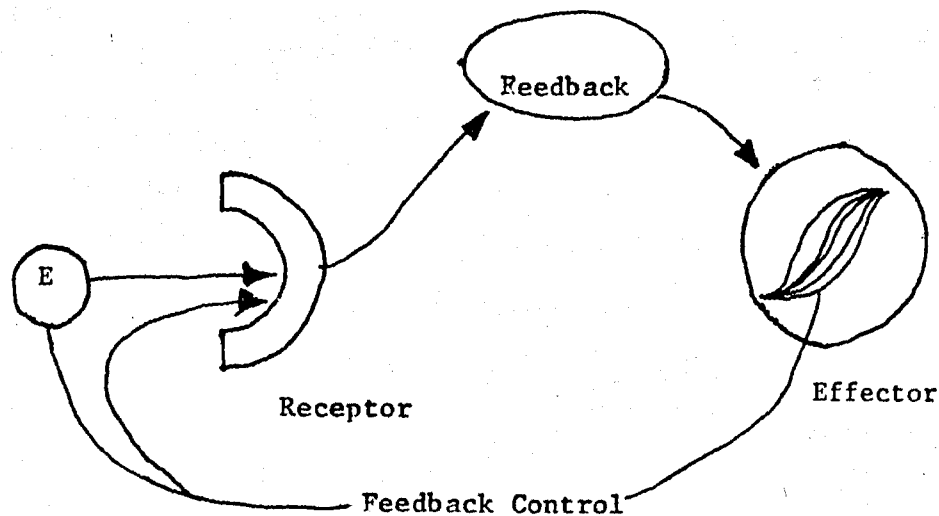
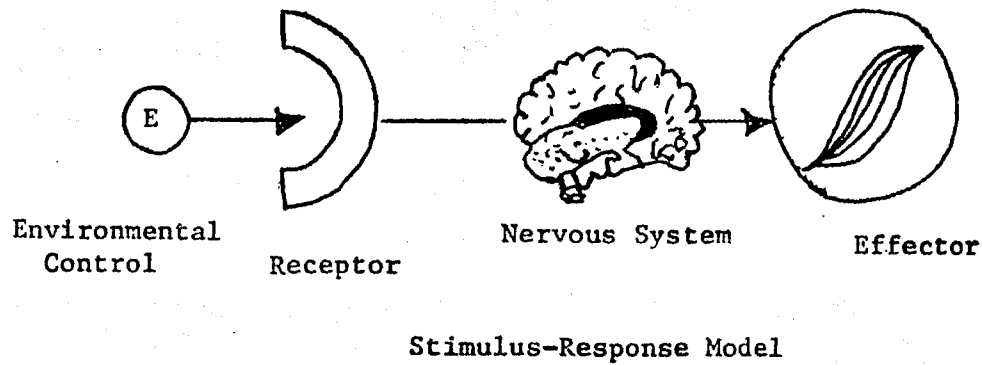


Figure 2

Feedback in behavior systems pictured as a reciprocal, dynamic interaction between muscular action and sensory input that is mediated by the neural system as contrasted with a stimulus-response model where environmental stimuli present discrete information to the effector for response. The S-R model is considered to be an open system since in this view the receptor part is discrete from the receptor aspect. The feedback model represents a closed-loop system since effector and receptor functions are reciprocally linked. (Based on Smith and Smith, 1970, p. 84).

The basic premise of a feedback doctrine of dance performance is that such activity is organized on a self-governed, continuous feedback basis, wherein active movements act reciprocally to control sensory input, neural processes and physiological functions. In the feedback interpretation, behavior is not a passive reaction to the environment; it is a process of self-generation and self-regulation of stimuli, sensory processes, and physiological functions by organized muscular activity to control both the internal and external environment.

Figure 3 is a more complex model of feedback control and organization in human response, such as dance motion. It indicates the multidimensional nature of muscular control of environmental stimuli, self-generation of stimuli, control of receptor sensitivity, activation of visceral functions and neural activation. It also demonstrates that all of these dimensions of control have feedback linkages between them for organizing and synchronizing themselves as a harmonious integrated system.

As applied to dance behavior, the feedback ideas just stated mean that the dancer generates his or her own movement on a continuous basis and dynamically controls its direction, force and timing by adjusting to the sensory, neural and physiological feedback that results from dynamic movement. The adjustments are made on the basis of the difference between the movement that the dancer generates and its effect upon the dancer's internal and external environment, as detected by the sensory and neural systems. This is not a cause-effect relationship as held by past stimulus-response theories of behavior

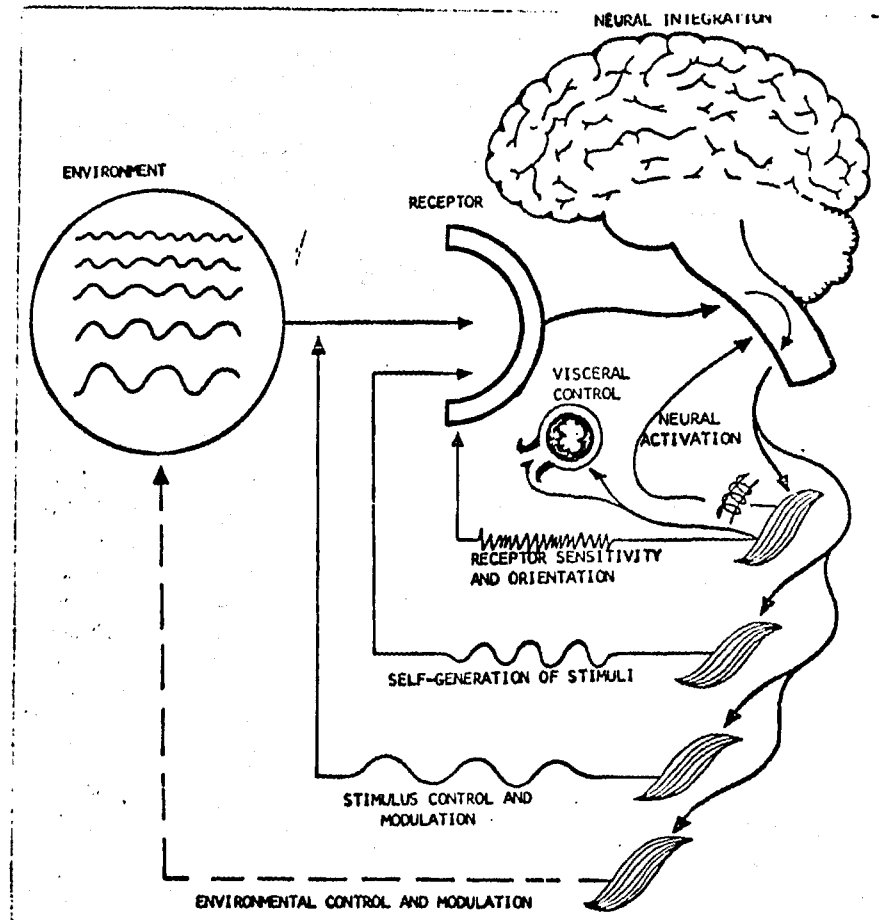


Figure 3

Parameters of feedback regulation of neural activation, organic and metabolic function, receptor sensitivity, stimulus modulation and selection, and sources of environmental stimulation by motions of the skeletomotor system (Based on Smith and Smith, 1970, p. 87).

since motion, as viewed in feedback terms, is continuously generating new conditions of stimulation whereby the organism guides and controls itself. The sensory, neural and motor aspects are reciprocally related on a continuous basis and the different levels and parameters of control are interlinked by yoked or connected feedback mechanisms.

As alluded to above, the properties of control and integration of the behaving system implied in feedback theory are: (1) it is self-governed; (2) it is a closed system operating through the continuous effects of dynamic response and the sensing and detection of these effects; (3) it guides both its sensing and responding by means of feedback control; (4) it integrates its constituent multiple level activities through feedback processes and (5) finally, its feedback control can be transformed by social interaction, as in dancing and the use of symbols such as verbal and non-verbal language.

Various lines of evidence are now available to suggest that a feedback doctrine is an essential formulation of the problems of control and integration of behavior (Bilodeau, 1966; Smith, 1971). Research in experimental behavioral cybernetics (Smith, 1971) has experimentally substantiated the theory as being operative in literally every mode of human behavior organization. At the Behavioral Cybernetic Laboratory, University of Wisconsin, various types of instrumental feedback techniques, including computerized laboratory methods, have been developed for experimental feedback analysis of human motion systems that are involved in response, perception, learning and

motivation. The results of research being carried out at this laboratory present direct evidence that human behavior is the result of highly integrated closed-loop feedback controlled systems functioning in terms of response-generated sensory, neural and physiological signals, as suggested by the diagram in Figure 3.

Mechanisms of Feedback Control in Dance Motions

If we apply ideas of feedback theory to dance behavior, we reject the commonly held notion that dance movement is a discrete type of response which is produced as a reflex or a train of sequentially linked reflexes caused by stimuli from the internal or external environment. Rather, we view the dance movement as an on-going dynamic event, whose force, time and space properties govern the characteristics of receptor input, neural function and related perceived events, as well as the physiological effects of fatigue, motivation and organic functioning which accompany the motion. That which the dancer sees, feels, and does both momentarily and subsequently is determined by the dynamic events of the dance motion and its capability to alter receptor input, brain function, and physiological changes.

The challenges in applying feedback interpretation to dance motions are: (1) to explain the specialized details of articulated reactions of the body and control functions characterizing specific performance skills of dancing such as leaping, turning, etc.; and (2) to account for the overall organization of behavior and physiological function which underlies and makes the articulated dance

movement possible. The aim of the present section is to describe the various mechanisms of feedback control and thereby make clear the systems factors in both specialization and organization of dance performance skills and dance exercise.

The cybernetic theory of behavior organization and control assumes: (1) that the feedback-controlled pattern of response involves postural, transport, manipulative tremor, and articulated receptor movements; (2) that motion is controlled and integrated by space, time and force feedback; (3) that different movements such as limb motions and posture are dynamically interrelated through a process whereby certain parts of the body actively track or follow other moving parts of the body; (4) that the feedback process depends on perception of motion and its resultant sensory patterns; and (5) that timing and rhythm of motion as well as the synchronizing of two or more movements are determined by processes of body tracking wherein one movement follows or tracks the sensory and neural effects produced by a second movement and vice versa.

Components of Motion

The results of various studies on body motion have suggested that organized movement, as in dance behavior, involves motorsensory feedback regulation of at least five levels or components of bodily motion (Smith and Smith, 1970). These components correspond to tremor, postural, transport, manipulative and articulated receptor movements. Cybernetic theory explains this multidimensional occurrence and integration of these components of common human motion. Figure 4

suggests in a limited way the interrelated operation of these five components. These five levels of motorsensory organization are separate in their control functions but each one must be integrated in task compliant configurations for every movement pattern in which an individual engages. The degree of integrated compliance of the five mechanisms to the task determines the overall organization as well as the efficiency of movement in particular motion patterns.

Studies have indicated that the different motion components vary in terms of their space, time and force properties (Smith and Smith, 1962). The gravity-sensitive postural mechanism is the most primitive and therefore the most generalized of the five systems. It functions not only to maintain the vertical position of the body in relation to gravity, but to adjust dynamically in this process to support, enhance, compliment and compensate the space, time and force characteristics of transport motions of the limbs and head. Every dancer recognizes the central importance of posture or placement in performing literally all dance movements. The placement of the parts of the body in specific vertical relationships constitutes the ground base or background against which all other decorative or symbolic articulations are organized and carried out.

Transport movements function to carry parts of the body through space by pulling, pushing, lifting, carrying, and orienting the limbs, torso and head in space. Transport motions are responsible for locomotion and other travel movements and, combined with manipulative motions, constitute the expressive language aspects of

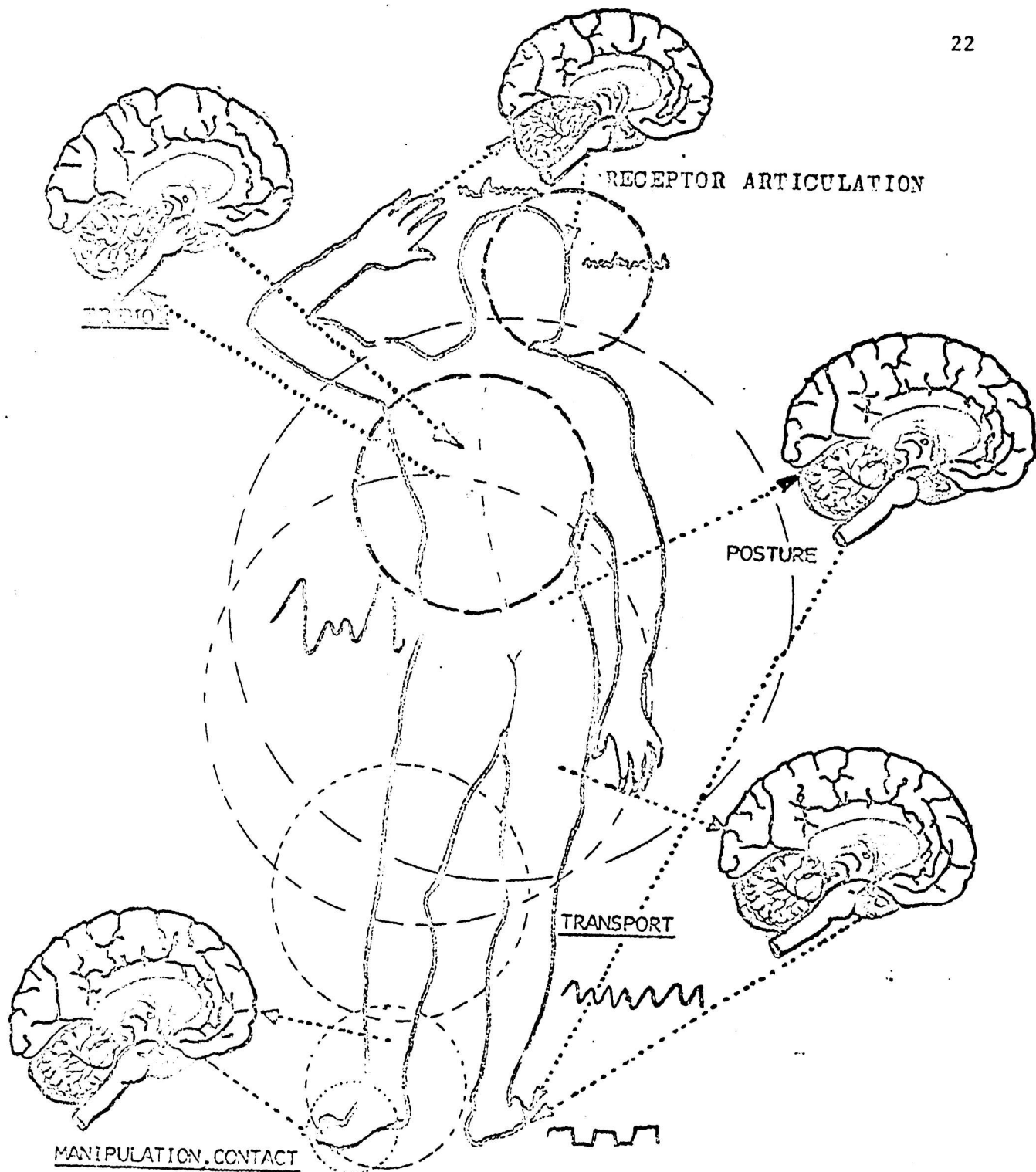


Figure 4

The primary reactive components of motion and response
(Based on Smith, 1971, p. 30a).

dance. These modes of motion control are responsible for the qualities of dance movement associated with specific muscle tensions such as are found in bound or free flow movements. The articulated manipulative movements of the body relate to facial expressions and small refined gestures of other parts of the body.

Tremor movements in the body represent the effects of resting muscular activity which serves to bring about small oscillation of a member. Tremor serves to keep receptors sensitive by preventing them from being desensitized. It is also possible that tremor movement acts as a pacer against which the other motor levels synchronize their spatial functions in time. For instance, breathing patterns are critical in accurate arm position in swimming activities (Smith, 1971) and it is assumed that this is the case in dancing.

The articulate movements of the mobile receptors such as the eyes and ears also help to determine receptor sensitivity but they are more importantly involved in orientation functions crucial to the functional specialization of all the components. For example, articulated movements of the eyes are important in all of their functions in fixation, pursuit, action and convergence in depth perception. In dance performance, the correct articulated orientation of the visual receptors is critical in turns, for example, where "spotting" is necessary to prevent general disorientation.

Coordination of Component Movements in Dance Motion

In the cybernetic view, even the simplest response requires simultaneous coordinated control of receptor, postural, transport, and manipulative systems governed and organized against a background of internal organic activity related to respiratory and heart action. The continuous coordinated interaction of these components is made possible by the closed-loop nature of the behaving system. Smith and Smith (1970) indicate that the spatially organized feedback circuits of the body not only locate the individual in space and guide his articulated movements but they also bring pattern and continuity to receptor inputs and thereby organize and determine perception.

In the feedback view, the various components of motion are tied together into unified time, force and space patterns by a process of mutual feedback control wherein the sensory or neural effects of motions are modulated and varied by a second movement and vice versa, so that the brain detects the space, time and force effects of the two movements in an interrelated way. The term body tracking is used to describe this process of feedback yoking of the motorsensory mechanisms of two or more movement components. The clearest examples of such body tracking are seen in visual-manual behavior in which the eye tracks or follows movements of the hand. In dance, however, many other types of body tracking occur. For example, in adjusting the arms for a port de bras, the eyes and postural systems are continually tracking the activity in the two arms and detecting the differences between their movements. This difference is dynamically integrated

dance. These modes of motion control are responsible for the qualities of dance movement associated with specific muscle tensions such as are found in bound or free flow movements. The articulated manipulative movements of the body relate to facial expressions and small refined gestures of other parts of the body.

Tremor movements in the body represent the effects of resting muscular activity which serves to bring about small oscillation of a member. Tremor serves to keep receptors sensitive by preventing them from being desensitized. It is also possible that tremor movement acts as a pacer against which the other motor levels synchronize their spatial functions in time. For instance, breathing patterns are critical in accurate arm position in swimming activities (Smith, 1971) and it is assumed that this is the case in dancing.

The articulate movements of the mobile receptors such as the eyes and ears also help to determine receptor sensitivity but they are more importantly involved in orientation functions crucial to the functional specialization of all the components. For example, articulated movements of the eyes are important in all of their functions in fixation, pursuit, action and convergence in depth perception. In dance performance, the correct articulated orientation of the visual receptors is critical in turns, for example, where "spotting" is necessary to prevent general disorientation.

throughout the body and adjustments not only in the arms but to position the body posturally to support the arms and to adjust critical aspects of organic and physiological functions to make the focal action possible. This process is referred to as body tracking since one part of the body is engaged in following the motions of another.

All motor adjustments are based on the integration of feedback from at least two or more dynamic body tracking systems. For example, as the dancer performs a complex turning body roll, feedback from the visual, vestibular, postural, transport and basometric systems is integrated and used in determining dynamic motor adjustments to the ongoing movement of the turn. It is the differences perceived between these movements that determines continuous controlling motor response.

It is possible to apply the concepts of body tracking to the explanation of the integration of component movements in dance behavior. In this view, the dancer determines the course of the dance by dynamic body tracking of the various anatomical motion components of tremor, receptor articulation, postural, travel, and manipulative movements which constitute a closed-loop reciprocally interacting system. The experimental data on the guidance and synchronization of this multidimensional system suggests that most dance movements involve extraordinarily accurate and precise dynamic coordination of spatial guidance and timing factors in order to create the appropriate effort-shape in each action or movement pattern.

Figure 5 illustrates the interaction of the coordination of various anatomical levels of motion involved in dance movement. The postural movements, with their coordinate mechanisms of gravitational and dynamic movement regulation, constitute a foundation upon which the bilateral movements of transport and the articulated movements of manipulation and receptor orientation are staged and integrated. Positive and negative tracking of the displaced hip and torso in this pictorial example is required respectively by the postural and the transport movement components in order to compensate for the effects of the motion on gravitational control. Both proximal and distal receptor systems of the body are precisely oriented to allow for the accurate body tracking involved in this movement. Finally, all of the foregoing activity is organized against a background of tremor movements at the same time, organic activities of the heart and respiratory system are integrated with the more gross anatomical motions.

Because the dancer operates as a closed system in which all of the components directly sense the effect of each other's movement and in turn respond positively or negatively to effect a desired movement pattern, it is possible for the dancer to perform smooth coordinate movements. The closed-loop nature of the system is the crucial factor in determining the continuity and cohesiveness of the integrated motion. The most important aspect of the behavioral cybernetic theory of how a dancer organizes and controls his own movement in performance is that it accounts for the ability of the

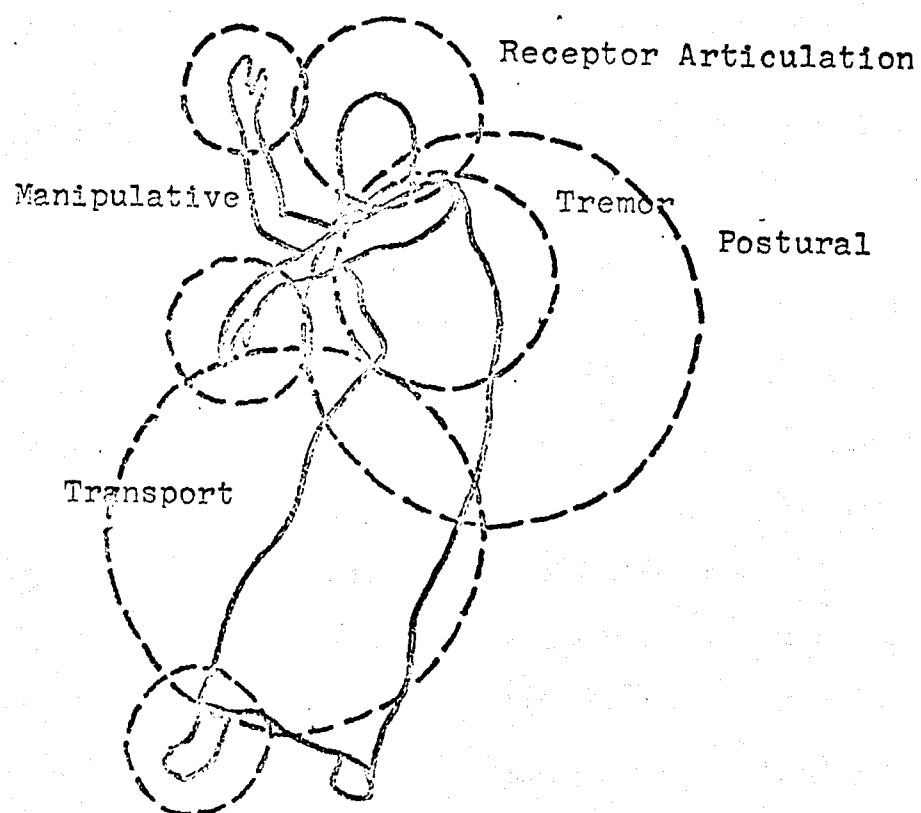


Figure 5

Interacting modes of body tracking in dance movement.

dancer to perform under multivariant environmental conditions at highly complex and compounded levels of locomotive, gestural, postural and manipulative movements of dance.

Based on the concept of multidimensional movement organization, it is possible to assume that the dancer acts as a self-guided system by organizing the different components of motion and sensory activities through integration of the different levels of movement to achieve the precise movement patterns that comprise his dance. Dancing involves all the components of motion in specialized expressive configurations.

Space, Time and Force Control of Movements in Dance Motion

The systems doctrine of motorsensory organization of motion that has just been presented states that the different postural, travel, manipulative, and articulated receptor movements are integrated on a space, time and force feedback basis (Smith and Smith, 1970). Each movement component is controlled by the space, time and force feedback compliances between movement and sensory and neural input, and is specialized and integrated with other levels in terms of its space pattern, timing, and force characteristics. An important assumption of this theory is that time and force feedback properties are derived from and are dependent on the spatial guidance factors. The idea is that the motor and receptor systems, as well as the brain, are structurally organized primarily on a spatial basis and that the brain functions to adjust timing and force of motion by altering and adjusting spatial patterns of motor response and related sensory inputs.

It is assumed also that motions are developed in childhood and learned in terms of their spatial feedback factors, and their time and force properties are adjusted to this guidance capability through learning. This indicates that in training the dancer initially emphasis should be placed on spatial guidance factors. More detailed training can be given in timing and force characteristics of performance after the novice dancer has developed a broadbased skill in spatial guidance.

Guidance of Motion

It is widely recognized both in the dance field and in anatomy and physiology that a movement is performed by a bone lever through an arc at a joint. This is called angular rotation. The dancer guides his movements in these arcs, in terms of visual, tactual and kinesthetic effects of the movements. For example, a dancer trying to duplicate someone else's movement tries to match visual display with his movement response. The degree to which kinesthetic feedback coincides with visual feedback determines the degree of accuracy. This correlation takes place primarily in the brain in the motor and sensory centers.

The spatial guidance factors in dance behavior can be explained in terms of two main aspects of spatial compliance between the movement itself and its sensory effects. The first aspect concerns directional control of movements. The second aspect concerns the timing of complex motions which evolve high speed action, difficult postures, interaction with others, and use of instruments and symbols. In the feedback theory

The spatial feedback theory of motion guidance assumes that the endless movement patterns that an individual dancer can learn and perform are specialized as direction-specific responses. These movement patterns are based on the detection of relative space-displacements between movement and sensory input at all levels of movement organization and control. In other words the dancer guides himself by attending to the geometric displacement between his movement and that of the sensory stimuli and neural effects caused by the movement.

Role of Feedback-Timing in Performance

In the view just stated, the time factors of dance performance are primarily derivative and dependent upon the direction and distribution of muscular contractions and their sensory feedback. Research on the effects of delayed feedback--i.e. the introduction of an artificial time lag between a movement and its sensory effects--indicates that the time factors in feedback are highly specific for control of each movement configuration and that timing cannot be varied without disrupting performance. For example, if a temporal lag is introduced between what a dancer is doing and what he or she perceives about the movement, general breakdown of control occurs. In other words, if the dancer must wait until after the dance to be told that her foot was not completely planter flexed it is too late to affect the performance. Such control based on awareness must be continually exerted during performance.

A critical item of evidence which indicates that timing of movements is not a matter of direct detection of the time process involved is indicated by the effects of motorsensory feedback delay on learning. Generally, individuals are very limited in learning to adjust to time lags between movements and sensory input unless spatial information is available that enables the individual to predict the future path of a motion and thus to span time in guidance of the motion. The effects of feedback delay also may be reduced if an individual performs simple repetitive rhythmic activity in which some prediction of future movement can be achieved. The meaning of all this for dance motion is that control of timing, rhythm and synchronism of movements involves recognition of the ways that motion can be adjusted space-wise and repetitively to effect good synchronism of movements.

Motor Performance and Expression in the Dance

Using the concept of feedback controlled motion, it is possible to describe the control factors and organization of body movements in the dance. In the cybernetic view, even in the seemingly simple act of standing erect, the dancer engages in a highly complex process of body tracking. Balance is maintained through mechanisms that sense and respond dynamically to minute displacements of the head, upper limbs, torso, and the lower limbs on generalized and articulated levels of feedback control. The upper portions of the body contain the kinesiethetic and labyrinthine motorsensory mechanisms that establish a rough balance that is refined by the visual system. The articulated

level of balance control results from basometric representation of spatially differentiated cutaneous feedback from the sole of the foot.

Body Tracking

Using a computer to measure the motion components of posture, Smith (1971) has shown that different parts of the body seem to track or follow changes in other parts of the body with almost instantaneous reaction time. In the high speed body tracking involved in postural control and other skilled motor behavior, body parts are yoked by closed-loop neurogeometric detection systems that make the reciprocating motion patterns characteristic of body tracking possible. In bilateral tracking situations, it is known that single neurons in the brain stem detect stimulation differentials coming from matched receptors located in symmetrical positions on each side of the body. When a difference is detected these cells respond by actuating motor outputs to regulate adjustment. Furthermore, these high-speed, feedback detector-actuator cells function in positive and negative body tracking to decrease or increase bilaterally-detected sensory variations in the moving body. In positive tracking, for example, the postural component of movement would allow the torso to follow the arm in a gesture to the floor accentuating the trend of the focus of motion. On the other hand, a negative tracking response of the torso would tend to cause a stretching configuration as the arm reaches out and the torso pulls away from the focus of motion minimizing its directional tendencies.

The exact role and extent to which dynamic feedback control and body tracking serves to organize and regulate the performance of movement tasks has not been fully investigated. It is assumed, however, from research already extant that body tracking is a fundamental mechanism in the integration of task specific configurations of the multidimensional movement components. In studies that are presently in progress it has been shown that in a time tracking task where the subject tries to beat time simultaneously with a hand and a foot, the hand invariably leads the foot by as much as .25 sec. Similar findings have been reported for coordinating respiration and arm movements (Smith, 1971). It is anticipated that this study on completion will substantiate the belief that certain parts of the body lead out as pacers and targets for other parts of the body to relate to through both positive and negative tracking in the ongoing highly complex process of motion.

All specific movement patterns of dance, including the various forms of locomotion and gesture result from integrated closed-loop regulation of posture, transport, manipulative, tremor and receptor movements. Each of these levels of movement organization control their own channels of sensory and neural input and motor output which interact dynamically to guide, synchronize and mobilize the specific configuration of space structured effort required for the task.

Socially Interactive Motions of the Dance

One of the striking phenomena of dance motion is the synchronism of movements which can be achieved between different persons

in partner or group dancing. Traditional theory in psychology and physiology has never been able to explain such remarkable synchronization of motion. In the cybernetic view, such social coordination of movement is an extension of the type of control which was described in body tracking. The control and organization of social behavior is similar to that of the individual behavior already discussed in that performance and learning are almost entirely dependent on dynamic feedback processes of the motorsensory systems of the individuals involved. In social interactions, however, instead of merely tracking one's own body parts in order to organize and control behavior, individuals track the movements of another person or persons on a closed-loop basis.

According to cybernetic theory, social tracking refers to the movements resulting from the mutual cross-yoking of the motor and sensory systems of two or more persons so that the movements of one constitutes a source of sensory feedback for the other and vice versa (Smith, 1971). In other words, when two or more persons are mutually engaged in performing and are coordinating their movements in a specific task, they not only detect what the other is doing but they generate responses in terms of the degree to which their movements correspond or compare with the position, speed and direction of the other's movements.

Modes of Social Tracking

The behavioral cybernetic theory of social tracking describes the mutual linking of the motorsensory mechanisms of two or more

people in feedback terms. It identifies at least three modes of social interaction that are of significance to dance and its study. They are: (1) unilateral imitation; (2) parallel-linked tracking; and (3) series-linked tracking (Smith, 1971). Figure 6 demonstrates the three principle modes of feedback control of social tracking.

The first illustration (a) symbolizes the imitative mode in which a child receives movement information from an adult which the child tracks without the benefits of reciprocal adjustments from the adult. Illustration (b) in Fig. 6 demonstrates two individuals receiving information about the combined effect of their behavior. On this basis they reciprocally control their reaction. This parallel mode of tracking makes highly accurate mutual performance possible. The series-linked tracking symbolized in illustration 6c shows a situation in which the woman receives the output information of the man and acts on it. He in turn receives that of the woman and bases his reaction on hers. In this mode there is an inherent delay in the systems nature of the interaction since the reactions are sequential. The performer's inability to act reciprocally is due to their inability to perceive the combined effect of their efforts as symbolized by the rectangular barrier in front of each individual in the illustration.

In addition to these three distinct interpersonal linkings, the theory of social feedback control recognizes that movements between persons can be cross-linked in terms of different types of sensory feedback. Tactile, kinesthetic, aural, visual, vestibular and other senses are continuously integrated in such cross-yoked control in partner and group dancing.

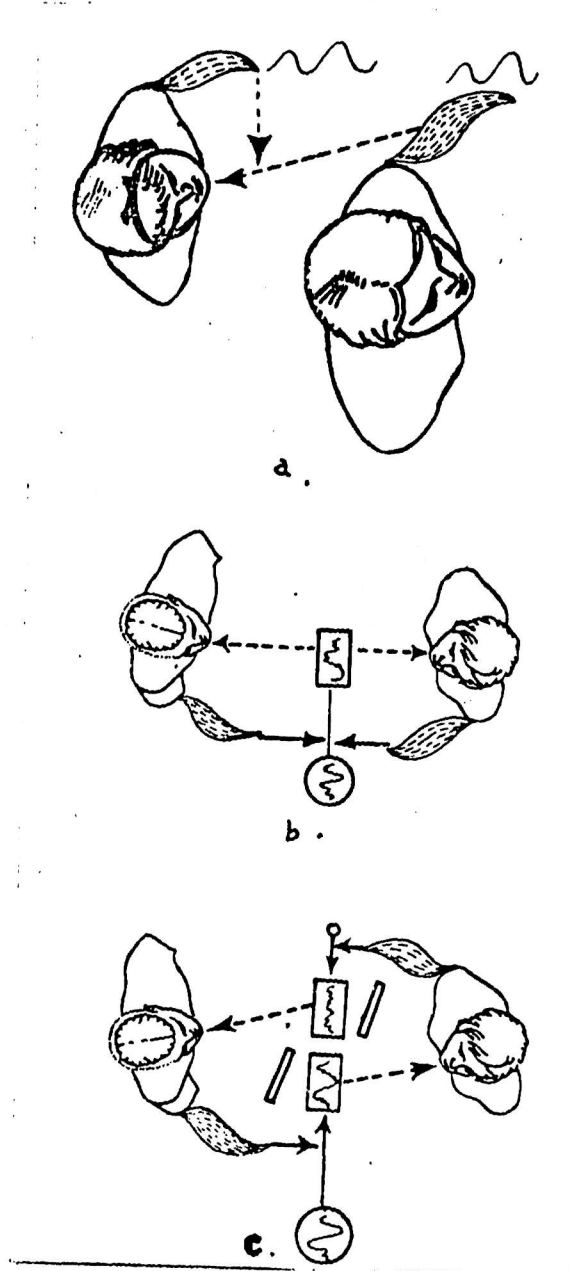


Figure 6

Theory of the modes of feedback control of social tracking: (a) imitative following or steering, (b) parallel-linked tracking with matched sensory feedback and (c) series-linked tracking (Based on Smith and Kao, 1971, p. 290).

Tactile sensory control of social tracking can be observed to be more accurate than visual control. A dramatic demonstration of this fact is to have two people lightly touch hands. While one of them moves in complicated patterns the other follows without losing hand contact. It has been observed (Smith, 1971), that some subjects are better than others at this manual-tactual tracking task. However, if the hands are separated only a few inches so that the follower must adjust for the partner's moving hand by visual feedback alone it becomes readily obvious that the visual mode of feedback is far inferior to the tactile-kinesthetic mode since even the best follower under tactile conditions is incapable of continuous smooth tracking under the visual conditions.

Tracking Exercises

Typical tracking activities consist of both negative or positive imitation of the movement patterns of partners, matching behavior of someone else without letting him know, and focusing or matching similar body points on one another, such as touching elbows and moving. Negative imitation would result when the follower compensates for differences between his own movement and the leader's. Positive imitation refers to maintaining the differences constant. Such mutual, interactive activities tend to be quite vigorous and seem to generate new and imaginative ideas for further activities. Smith (1970) has asserted that "finger dancing" and other such exercises should be engaged in regularly by parents with their

children to engender creativity and a foundation for later perceptual skills. It is further held that this type of activity is extremely important in the development and maintenance of fundamental movement skills required of a dancer. Not only should mutual tracking activity be part of the childhood experience but it is a vital part of the training of a dancer in adulthood and serves as a stable sensory motor system against which other complex and symbolic dance movements are organized.

In parallel-linked tracking, each of the two or more individuals get a continuous combined feedback indication of their total movement effect in the environment. This is known as a systems feedback effect (Smith, 1971). Parallel-linked tracking differs from series-linked tracking in that the feedback display in parallel-linked behavior represents the combined effect of the group's behavior in the environment such as in social dancing whereas in series-linked social situations each individual is dependent upon the response of another member of the group for sensory input and only a part of the total effect of the group's behavior is continuously and immediately available in the form of feedback. Dialogues such as in conversation or in call and response dances typifies this type of social interaction.

Events of Social Tracking in Dance Behavior

Because the practice of dance at all levels has never depended on theoretical explanations for its existence, it is not surprising that dancers have succeeded in all times in performing highly articulated movement patterns in relation to other dancers,

musicians and audiences without identifying the fact that they were engaged in acts of social tracking. Nevertheless, these dance interactions are believed to depend on such tracking. It is suggested that, to be successful, even the most rigidly patterned dance depends upon the abilities of its performers to track each other, the musicians and the audience. Closed-loop conditions in performance are achieved when the motorsensory systems of the musicians, the dancer and the audience are yoked together in mutual dynamic tracking of each other's behavior. Martin (1939) identified this process when he stated that the audience member perceives the dancer's performance by projecting the movement of the dance on to his own kinesthetic system. Highly refined skill in social tracking is extremely important for performance in virtually every dance form. This is obvious in those activities such as social dance, folk dance and other types of dance where partner or precision group activities are common. The importance of social tracking skill, however, is universal in all areas of dance performance since it is the fundamental mechanism of social organization and control. Even the dance soloist is dependent upon his or her ability to establish a closed-loop interaction with musicians and the audience when they exist.

In highly skilled dance performance the various modes of social tracking are applied interchangeably. As one dancer picks up upon the movement cue of another unilateral tracking is in effect. Then both dancers may engage in a series-linked type of body or movement dialogue in which one performer makes a gesture which another

dancer acknowledges and then adds further comment in the form of movement language. Such a movement dialogue can be likened to group generated creative storytelling. In set dances where it is important to mutually generate predetermined movements and designs, the function of parallel-linked tracking becomes obvious since all participants are concerned with mutually contributing to the whole general effect of the performance on an ongoing dynamic basis. It should also be pointed out that the several types of sensory feedback continuously vary in their importance to performance. In social dancing and other dances where active partnering is used, tactile feedback is paramount to performance efficiency. In other kinds of dancing, auditory, visual or kinesthetic feedback may be dominant in synchronizing movement. In all dancing, however, all of the senses are multidimensionally involved in feedback regulation of the motion.

Group Improvisation as Social Behavior

In parallel-linked tracking situations all parties concerned are locked into a single sensing responding system that organizes and controls movement or behavior of the whole system in the same way that an individual controls and organizes his own movement or behavior; that is, by sensing the whole effect of his own movement on the environment in order to determine further appropriate movement and receptor orientation. In a social system just as in an individual's system, immediate and comprehensive feedback is essential to continuous accurate performance. The parallel-linked system provides such instantaneous, continuous and comprehensive feedback of the joint effects

of all members of the social system as it operates on itself and the environment. In such a system each individual has the whole display of the combined effect of everyone's response so that everyone is capable of adjusting the overall performance of the whole system. A most efficient approach to the development of the personal and social skills has long existed in the field of dance (Frank, 1960). It is dance improvisation. This author wants to point out here that dance improvisation is not only an excellent general education and dance training tool, but that dance improvisation represents a high level of human movement performance.

In modern times dance improvisational activities have generally existed under a cloud of question, with attitudes ranging from benign contempt for the activity to outright scorn for those who indulged. While it is a well-known fact that Isadora Duncan's dance art was fundamentally improvisational (Duncan, 1924), the imitators that followed her quickly dampened interest in improvised dance performances (Martin, 1939). Martin (1939) has pointed out that the emotionalism that seemed to underlie the dancing of lesser performers than Duncan went a long way in causing the pendulum of taste to swing to the other formalist extreme.

Dance educators (Mettler, 1963); Lippincott, 1967; Hayes, 1955) have cautiously advocated improvisation as a means for "finding" fresh movement material and for developing "freedom," confidence and other limited objectives (Frank, 1969). Dance improvisation has commonly been thought of as random, undisciplined and uncritical behavior spuriously labeled dance. It is often regarded as that which one does when nothing

specific was planned. To be sure, dancers have always been expected to be able to "shine" or improvise steps and unplanned actions, but within the theater dance profession and in the educational setting "unset" dances have traditionally been viewed as strictly second class.

In light of the cybernetic theory of social tracking being applied here to dance activities, it is possible to suggest that dance improvisation based on parallel-linked or series-linked social tracking represents a high level of skilled dance performance. In such dancing the dancer establishes a closed-loop feedback controlled relationship with himself, the other dancers, the musicians and the audience and together they all mutually create the performance. If historical evidence of the nature of dancing in proto-historical Greece is not misleading (Lawler, 1964), it can be assumed that parallel-linked and series-linked modes of improvisational dance performances are as old as civilized man himself.

Socializing Nature of Dance

In the cybernetic view, it is assumed that a principle function of dance throughout the ages has been to control and organize social interactions of society. It is a rare occasion in which an individual dances alone. Dancing is most often a social phenomenon in which two or more individuals cross-yoke their motorsensory systems to mutually guide each other's behavior in symbolizing the many forms of natural social interactions in sex, emotion, fear, celebration, and related activities. It is on the basis of this mutual feedback

regulated behavior that cultural and symbolic systems have meaning.

Dance has always been prominent in cultural processes as a social vehicle which determines the form of the religious, sexual, military, civil, marital, and funeral rites of mankind. It is believed that all of these rituals can be explained in terms of the various modes of social tracking.

In the next chapter evidence in the form of a summarized history of dance culture showing dance as having feedback effects on the people and their cultural practices will be presented. It is assumed that if evidence of persisting feedback effects on dance activities can be demonstrated it will stand as direct proof of the theory of dance expressed in this present chapter. It is the overall aim of this thesis not only to articulate a feedback theory of dance but to extend this theory to illustrate or show how dance has functioned as a cultural tracking process through out all known eras of human endeavor. With such a substantiated theory it will be possible to make accurate assumptions about the importance of the universal nature of dance in all cultural settings.

CHAPTER 3
HISTORICAL EVIDENCE FOR A CYBERNETIC THEORY
OF DANCE BEHAVIOR AND DANCE LANGUAGE

In the preceding chapter, an outline for a cybernetic theory of dance behavior has been presented. No systematic attempt has been made to present experimental evidence which substantiates this theory as applied generally to human motions, including dance movements, since such evidence has been summarized elsewhere (Smith, 1971; Smith and Smith, 1973). It is now appropriate to pursue the concern of this paper by asking this question: Can evidence of a general or specific nature be derived from facts regarding the development and evolution of dance forms which would substantiate the view that this development and the patterns of motion used generally follow behavioral cybernetic principles, as these can be derived from the general theory already summarized. If evidence can be produced to show that dance functions in culture according to feedback principles in controlling and organizing individuals and social groups, then such evidence can stand as direct proof of the systems theory of dance being presented in this thesis.

Dance Behavior as an Organized Cultural Control Process

The first question posed by a behavioral cybernetic interpretation of dance forms is whether dance behavior has represented some systematic means of more or less continuous self regulation of

the environment and physiological function at different periods in human history. That is, has dance functioned cybernetically as an organized control process in cultures as well as being an organized form of feedback controlled motion. It is believed that evidence regarding the evolution of dance forms coincides with the cybernetic theory of evolution of behavior and technology which may be derived from the general theory of feedback control and organization of motion, as described in Chapter Two. That is to say, suggestive evidence can be presented that every phase of the evolution of historical dance forms exhibit control characteristics which conform to other aspects of control and organization of culture in particular evolutionary periods.

Evidence can be assembled from historical information that dance forms demonstrate the efforts of man to grasp and control certain aspects of the dimensions of time. According to this interpretation, not only does dance at various evolutionary levels reflect the degree to which human time has been brought under conceptual and biological control, but it is also indicated that dance has been a prominent mechanism in exerting and determining control of many aspects of temporality. Thus, the dance has played a vital feedback and systems role in different levels and processes of human evolution. Such an interpretation of dance as an organizing and controlling principle in the history and evolution of man represents a heretofore relatively unexplored and undeveloped set of ideas. Nevertheless, the value of such an interpretation which accounts for the universality of dance

and the persistence in evolution of different dance forms has become clearly evident with the increasing volume of raw data collected by dance ethnologists from all parts of the world (Kurath, 1960).

The extent to which the facts of evolution of the dance conform to the cybernetic idea that such forms were used as one of many ways to mark, track, and control calendar, seasonal and year times can be illustrated best by presenting a summary of the evolution of human dancing as interpreted by behavioral cybernetic theory.

Time Perception

In the cybernetic scheme of evolution developed by Smith (1962), it is held that man has overcome the inability of animals to directly perceive time by transforming his space organized feedback systems of movement to track some of the dimensions of time. To do this, he has devised tools, architecture, marks, clocks, clock-like machines, and symbol systems such as language and ritual activities, which transform spatially organized perception into time information. As a result of developing these means of dealing with time, man has learned how to regulate and control his cultural behavior and environment in terms of human time processes which are not present in the animal world. He has gained concepts of before and after, then and now, future time to be anticipated and prepared for, past time to remember and temporal continuity, as well as many other aspects of time.

The cybernetic conception of time is radically different than the traditional notion that time is universal and absolute. It holds that time constitutes an infinity of modes and magnitudes. Smith (1962) explains that "every particle and package of energy in living and

nonliving systems is time specific in action relative to its particular form and structure." If this is so then it can be assumed that the long struggle of man to gain perception of the multitudinous facets of time has yielded only a modicum of success in that only a relatively few of the aspects of time have been discerned.

Cultural Evolution Through Symbolic Behavior

In this theory, time, as it relates to biological systems, is not universally perceived and acted on in identical ways by all animals and in all cultures. Anthropological evidence for this assumption is very extensive. Hall (1959) has observed the relative temporal perception from culture to culture and Mead (1955) and many others have given evidences of relative time as it relates to culture. Based on these facts and the realities of biological organization that have been discussed here it is believed that culture, by definition, is comprised of the distinctive and integrated accomplishments of man in tracking time at ever more efficient and perceptive levels through the process of instrumental or symbolic feedback controlled behavior. Symbolic behavior, as it is used here, referred to acts that represent more or other than their real time and space characteristics.

Figure 7 graphically illustrates the progressive and integrated cultural achievements of man related to time tracking proficiency. As indicated by the heavy line, this evolutionary development has been continuous over what is assumed to be approximately a million-year-period. It should be noted that when a new



Cultural Evolution
Log 10 Time Scale
Figure 7

level of sophistication of time perception emerges that the older levels do not discontinue but rather they persist and are integrated into the whole system that is dominated by the newest level of perception. In this way, the continuity of evolving forms is maintained. The graph distinguishes seven main time related phases of distinct cultural adaptations to improved instrumental behavior in mastering some of the aspects of time. They are (1) retention of tools (this is assumed to include dance as a time regulating process); (2) making tools in a cave environment; (3) village building; (4) temple building; (5) city building; (6) the development of industry and (7) modern world wide industrial era. This indicates that each of the levels of cultural systems has been determined by the distinctive methods of instrumental or symbolic clocking and perceiving of time.

The general evidence for the ideas summarized in the graph in Figure 7 as a theory of evolution is very exclusive, and has been summarized by Smith (1965) in a survey of the evolution of work and technology. In addition, general surveys of the evolution of pre-historic timing processes, as summarized by Marshack (1973) and Nilsson (1920) also provide extensive evidence for some phases of the evolution pictured in the graph.

Cultural Tracking

The crux of the ideas given in the theory and facts underlying Figure 7 is that through the discovery and capturing of many dimensions of human timing by use of tools, man has extended his capabilities of body tracking and of social tracking to diverse forms of cultural

tracking. The term cultural tracking refers to the process whereby traditions are formed, extended and modified by social interaction between individuals, groups, and institutions such as in dancing. Such cultural tracking has involved not only use of tools but closely related transformation of the motorsensory mechanisms of behavior by language and institutionalized modes of behavior and social organization. Cultural tracking also has served as the cybernetic or control basis of organizing and encouraging work, creating law and governments, and organizing selective education.

The interpretation of the evolution of dance behavior throughout the ages which is suggested here is that dance forms have been developed as critical components of cultural tracking in both direct timing and symbolic representation of functions of time. Thus, it is believed that the expressive and symbolic behavior of dance has not been fortuitously determined and evolved. It is believed that the behavior of the dance represents processes of using movement symbols or representational behavior to perform active operations upon the environment, on the audience and on the dancer himself which interact not only in dynamic reactive ways to mark time in dance festivals but symbolically to project the future and the future actions of the participants. It may be assumed that the movement traits of all dances, including historical dances, reflect systematically transformed characteristics that are typical and coherently compliant with motor-sensory and integrative mechanisms of their originators.

Following the idea just stated that manifestations of culture are controlled by, and reciprocally control in turn, the techniques

and modes of behavior in encoding time and in controlling behavior over time, and that dance behavior has formed a critical part of such timing, it may be assumed that all dances throughout the history of man can be understood in terms of their time-related function. In relation to this basic assumption of the cybernetic idea of the evolution of dance is the assertion that as progressively greater levels of time perception and control are achieved the dance forms and timing processes constituting the past levels of comprehension and control persist in time and are integrated into the improved techniques and forms. Indeed, it is believed that the new levels of perception and their concomitant forms are based on and derived from the older levels. This means that dance forms can be expected to be progressively more diverse in historical time due to the fact that each new level of dance behavior represents the feedback controlled and integrated accumulation resulting from the mutual interaction of earlier forms.

Based on the dual hypothesis just stated, it is possible to describe an overview of the evolutionary progression of dance that conforms to Smith's (1962) cybernetic concept of cultural differentiation and evolution. This concept is illustrated in Figure 8 which shows how the successive levels of instrumental and institutional adaptation emerge as new modes of tracking and symbolizing time in dance activities. The graph in Figure 8 shows how the forms of dance in the course of the evolution of mankind have related to these adaptations. Each new level of adaptation is differentiated out of the integrated context of all prior levels.

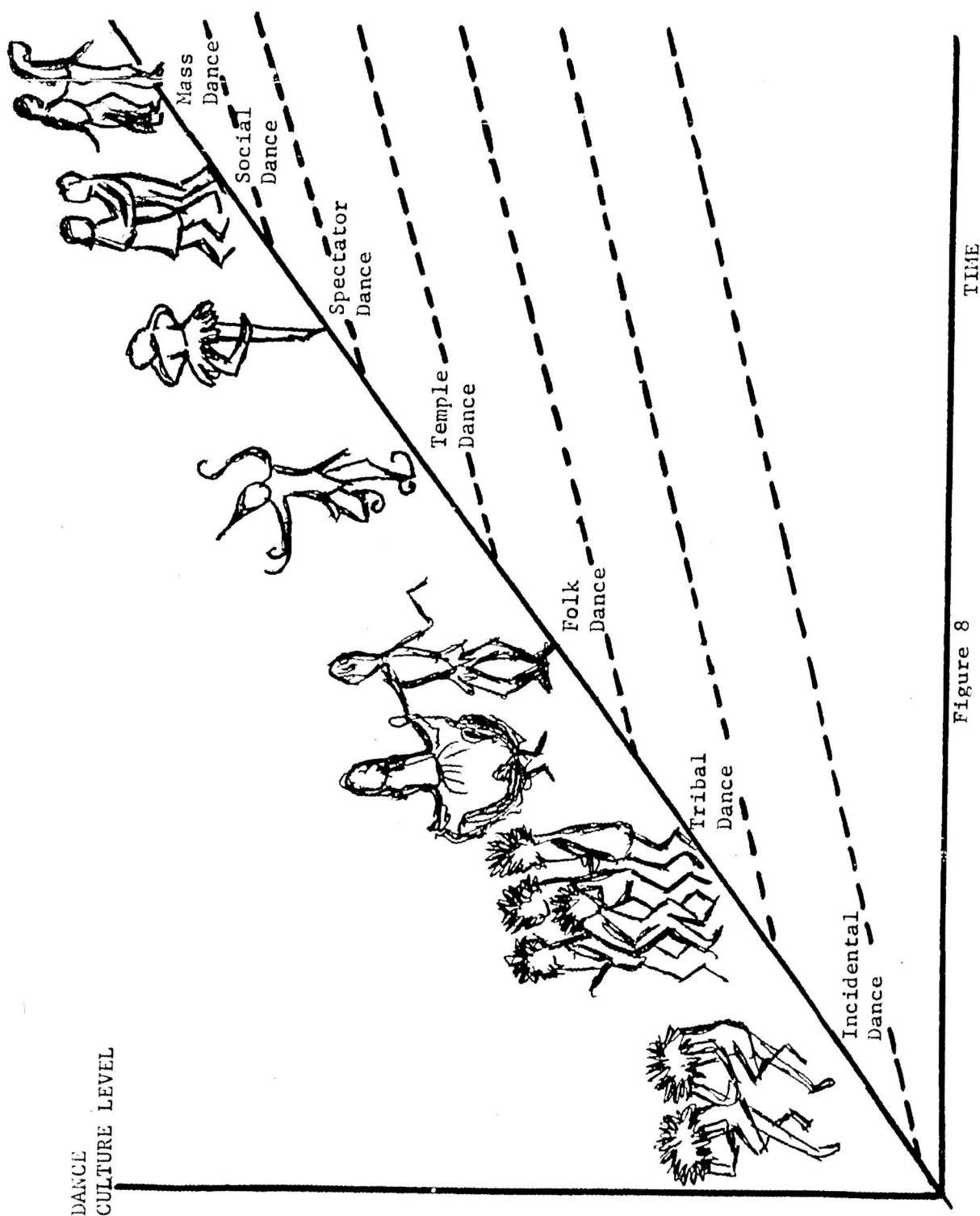


Figure 8
Evolution of Dance Culture

The graph shows that the overall course of the evolution of dance is continuous, accumulative and progressive, leading to more complexly organized and diversified dance forms. The illustration also indicates the fact that the older phases of adaption persist and continue to evolve at their own rate while newer phases emerge. Because of their greater scope of time conceptualization the new forms dominate and control the integration of older forms. This accounts for the fact that in contemporary dance culture all of the levels of dance behavior that have been responsible factors in the full evolutionary development of man coexist in time and space. They are comprised of the extremely rich fabric of incidental dances performed by animals, nomadic tribal dances (exemplified by Australian agorigines), primitive dance of village tribesmen, dance drama and folk dance of temple societies, spectator dances of mercantile cities, social dance of the factory cities and mass culture dance of the current international industrial society.

Incidental Dances of Animals and Hominoid Precursors to Man

The principle function of dance throughout all time and even in the present has been to act as a timing process at molecular, cellular, organic, physiological, individual and social response levels in giving man greater control of the fourth dimension. There are many evidences linking dance to timing activities in both man and animals. The unison saluting action of male fiddler crabs appears to be a dance related to timing the mating cycle. The peculiar mating dance of the fruit fly *Drosophila*, in which the male fly rapidly circles back and forth around the female in precisely timed 330 degree arcs, is another

example of a time structured animal dance. When the female's movement has been controlled by the male's circling, a tapping dance begins in which the male establishes a tapping rhythm that he applies to the legs and abdomen of the female. After this point, if the female is receptive, the actual mating takes place (Ehrman, 1971).

Examples of dances that are obviously related to time functions have been observed in virtually every family of animals. The dancing stilt birds of South Africa observed by Sach (1939) were engaged in highly synchronized, moving geometric patterns and did not seem to be involved in any kind of sexual behavior. The anthropoid ape dances cited by Sachs (1939) are distinctly time structured and in most cases clearly not related to mating activities. In contrast, the colorful cichlid fish perform exquisite slow motion waltz-like dances related to their mating activity (Meerlo, 1960).

That dance among early forms of man was basically a timing activity can be assumed for numerous reasons. It is most likely that, in the same way that early man and other advanced animals discovered the incidental utility of using a stick or a rock instrumentally, man recognized the numerous advantages of dance activities that probably incidentally resulted from social tracking situations. Among these advantages were the synchronizing effects of the organic and physiological components of energy production and utilization as well as the honing of the timing factors in movement integration and efficient response patterns. The development of greater self-regulated precision in locomotion, posture and articulated motion no doubt gave significant

advantage to man, especially when it is considered that these developing movement capabilities were dynamically interacting with other tool-using behavior.

In addition to the organic and physiological advantages derived from dance activities by primeval man was the sense of dynamic unison timing that was to be had from the mutually controlled movement patterns resulting from dancing with other individuals. The recognition that others in a peer group shared a common temporality was an important element of community coherence. It is known that animals are generally capable of the social tracking that is characterized by the kind of dance activities described here. This movement performed as incidental instrumental behavior by prehominoïd species was probably comprised of reasonably exact parallel space patterns and directly linked timing, with the individuals depending extensively on each other's tactual, visual and auditory stimulation for guidance. In other words, these activities were no doubt leaderless, unison movement events that were undistinguished from the similar activities of other animal species.

Nomadic Tribal Dances

However, it is believed as man began to retain tools of time control for continual use and projective operational processes, the distinction between human and non-human timing began to become apparent. In conformity with cybernetic theory it is postulated that when the developing sense of common time derived from unison dance movement activities among hominoids was retained and specifically repeated for

the purpose of renewing that sense and expanding its scope among the group, that the bridge had been crossed into the human experience.

As man became more and more distinct from the other animals due to the instrumental feedback effects of his using tools in incrementing his control of time concepts and in turn improving the tools in this process, the dancing probably became more varied and more deliberate. By the time the level that Smith (1962) identifies as the tool-making phase of development was reached prehistoric man was probably making his dances in the same way that he fashioned other environment-controlling tools, that is, by projecting and planning ahead in designing the dances and dance events for anticipated eventualities.

These eventualities were no doubt as varied and unique as the life of the individual and his environment could afford. It is known that primordial man developed extraordinary temporal control over the animals in his environment to the point that whole families of animals were made extinct prior to proto-historic times. One of the prominent methods of exerting control of the animal populations was through animal dances in which dancers mimicked specific animals in order to gain power over them. This ability to symbolically manipulate the presence and behavior of an absent animal constitutes control of a dimension of time that is similar in sophistication to modern film and television techniques in time-binding the images and sounds of specific events.

The effectiveness of some animal mummery dances in virtually gaining control of the animal that is the subject of the dance can still be seen among the Aborigine tribesmen of Australia where some individuals are so skilled at representing the wallaby in movement and posture that they can enter into a wild herd of these extremely shy animals and lead them into traps or selectively kill one or two by hitting them over the head with large stones without alarming the rest of the band.

This example of controlling aspects of time through symbolic behavior serves as an excellent model of the means whereby an individual gains a sense of time through space organized patterns in order to thereby control events in time. It is known that this nomadic tribal society is entirely space organized to mark events, loci and group activities and that the aborigines carry on repeated and extensive rituals in specific places and at determined times. In this way, they represent the continuity, succession and extension of life. In the case of the animal mimicry just described, these hunter-dancers reproduce the space determined movements and postures of the wallaby by yoking themselves to the animal in mutual social tracking when it is present and by memorized movement patterns of the animal's behavior in its absence. In either case, significant control was achieved over the animal in time. Since the aborigine had no way of remembering and knowing of the time continuity of an animal, object or individual when they were not present, his generation of symbolic movement and designed objects served in the same way that memory in a modern man does to assure him of the time continuity of the components of his world. The process also served to

control the event in time in which the hunter-dancer was able to capture or kill the wild animal, so in a most direct way it was an essential means of survival.

The entire life of the aborigines was filled with ritual dance ceremonies that went on from day to day without break. This continuous, danced-life process is believed to have been the aborigine's only way of tracking the objects and events in his life as they changed in time. The practice of continually and repeatedly performing his ritual "clocks" served to pace his life in the same way that a wristwatch regulates and orients a modern man. Through his dancing the aborigine was able to track time as well as the continuity and succession of events in time.

Anthropologists have long noted the extraordinary skills of survival and the complex symbolisms that comprise the culture of Stone-Age people. The skill of these people need not stand as an enigma if it is recognized that in an evolving culture the older levels of adaptation do not cease with the advent of newer more time perceptive modes of action but rather they persist in time and continue to evolve at their own rate parallel to the progressively newer cultural levels. The prolonged success of the aborigine in his extremely hostile environment constitutes a clear observable instance of the validity of this axiom. The aborigine must not be considered to be any closer to primordial man than so-called modern man inasmuch as his dances and other aspects of culture have been evolving just as long as that of a contemporary European but at a lower time-perceptive level.

It is postulated that in the course of developing ever greater control of the dimensions of time through dance behavior and other symbolic manipulations, man developed the precursors of many of the forms of dance that are now known. It may be assumed that erotic, sex-related dances played important roles in the feedback timing and regulation of sexual behavior of early man. Further investigation into the subject might well reveal a systems relationship between the de-cycling of sexual receptivity in the female and sexual dance activities. These dances have been prominent all through the history of man. Lawler (1964) explains that the Greek writer Lucian traced dancing all the way back to the time of the creation of the universe and the appearance of Eros, god of Love. Certainly the many orgiastic dances of both the Greek and Roman cultures were related to the temporal regulation of sexual behavior.

The social dances of the contemporary world constitute the continued practice of feedback regulation of sexual behavior in present cultures.

Influence of Dance Forms on Organization of Behavior

In the cybernetic interpretation being attempted here, the dance has served not only to aid different levels of culture in perceiving and tracking time, and in controlling time for complex cultural organization and management of work; it also has contributed to behavioral and psychological organization of man in the past. One such influence of this sort that can be recognized and speculated about is the influence of dance rituals and dance festivals on memory and projection of the future.

According to cybernetic theory, long-term memory in man and in organized culture has been advanced by creating social, instrumental and architectural forms that serve to capture time and thus refine control in projecting the future. Basically this means that memory operates to record the pattern of activity in learning, thus creating a spanned temporal memory record of past response (Sussman and Smith, 1969) which can be used to predict or project future action. While it is true that dancing leaves only a dynamic trace of action, when this action is marked so as to recur at particular places and intervals, it becomes an instrumental and symbolic operation that spans time and enhances memory. In primitive cultures, dance ritual in festivals and ceremonies are universal and far more frequent than in modern cultures, and are used in these primary cultures as specific time-marking activities.

The experiments of Sussman and Smith (1969) shed light on the fact that memory is not only a dynamic time-spanning process that records past movement but additionally it operates as a feedforward control process to project movement into the future. This is basically the means whereby instrumental or symbolic behavior affects both control of the environment and the dancer on a time-projected basis. By virtue of the time-spanning nature of symbolic movements, dance functions as a rudimentary timing process used by man in controlling internal and external environmental objects and events.

The Language Function of Dance

The single most important concept in considering dance in terms of cybernetic instrumental behavior is that just as an individual

operates on his own internal and external environment by using verbal language in both vocal and subvocal forms, the dancer operates on this same environment using a language comprised of overt body motion. It should be clearly understood that speech is the product of neuromuscular activity in the same way that dance is, and that both are subject to the same kind of transformed feedback control. As in the case of speech, expressive movements are organized in dance for cultural use by being designed into symbolic and informational (language) operations. Just as vocal language is composed of specialized feedback-controlled movement of the intercostal, breath and aural systems, so dance employs specialized overt body movement systems that are organized and controlled through dynamic patterns of mutual cooperative interaction.

As noted earlier, social tracking refers to an interactive process that is dependent upon each organism having its sensory input locked into the continuous motor reactions of the other organisms of its group through movement-controlled feedback to those inputs. In this way, the organisms become locked together in a common system that itself is self-regulated just as an individual organism is. As has been pointed out in another section, the mechanisms for social tracking are built-in and reflect the evolutionary characteristics among the species that enable them to maintain themselves in an organized way.

The behavioral characteristics of social tracking activities have been identified by Smith and Smith (1968) as: (a) exact spatial

parallelism of activities; (b) directly linked timing of social interactive response that is more precise than discrete response to external stimulation would permit; (c) sustained interdependence of two or more organisms on mutually generated tactual, visual, or auditory stimuli; (d) synchronized rhythms of motion in two or more animals; and (e) sustained guidance of one animal by another. If these criteria are applied to man's behavior in dance activity the mechanisms of selection of distinctive movement patterns becomes clear. The fact that man, due to his broadbased adaptive flexibility is able to successfully vary the modes and degrees of these tracking traits, indicates the capability for specialization and expressive variation available to him in the development of dance culture. It also lends support to the concept that dances seem to progress in time from simple to complex forms (Kealiinohomoku, 1969). This would be due to the progressive ability of men at evolving levels of development to successfully deviate from strict compliance in the social tracking situation.

Polygenesis of Similar Dance Patterns

It has been thought that all cultural traits have derived from single sources (Hornbostel, 1933) so that when they are found in more than one area, cultural interchange is assumed. However, the interpretation of evolutionary development put forth by cybernetic theory points to the likelihood that since cultural behavior is determined by various levels of proficiency in tracking time, it is possible and likely that the polygenesis of similar cultural traits might take place.

Smith (1971), for instance, has pointed out that virtually every modern culture has been through a temple phase. It also has become generally accepted, in light of the wide distribution of some fundamental instruments such as the hand ax and the bow, that multiple origins are plausible. Many prehistoric tools have similarities that are obviously based on their compliance to the human factors of a positional hand contour and critical timing factors in tool use (Smith, 1962).

The fact that such evidences of polygenesis exist among persisting artifacts of prehistoric culture gives reason to assume that similar movement patterns and symbolic dance activities could be anticipated among different cultures irrespective of cross-cultural relationships. This is in keeping with the idea that the specific forms and styles of human behavior are determined by spatially controlled transformations of the feedback mechanisms of behavior through instrumental operation.

Similarities of dance forms, like the similarities of grammar in languages throughout the world, may be attributed to the symbolic control characteristics of dance forms. The symbolic operations of dance movement consist of the dancer's use of movement patterns to represent related but different movements of other individuals, animals or objects. He may reduce or enlarge movement, translate, elaborate, or transform movement patterns related to situational behavior. Symbolic movement can represent stylized or specific movement characteristics of individuals both real or symbolic. It can express emotions and feelings by conforming with

discernible limits to the muscle tension configurations associated with such states. Symbolic dance movement can in fact accomplish all that speech can do in the way of pointing, denoting and describing actions and interactions between individuals, objects and events and in so doing manipulate these individuals, objects and events in their absence.

The similarities of dance forms in different cultures may represent commonalities in use of dance forms for environmental control. The classical dances of India and the dances of Bali are excellent examples of how the events and individuals comprising the cultural and mythological heritage of these people are encoded in time-spanning dances that not only make it possible to preserve their remembrance but also afford manipulative control of the events and individuals related to them, thus making heritage a dynamic self-regulated process.

Preliminary studies of the religious dance ceremonies of the Indians of central Brazil comprising the Xingu groups found in the Parque Indigena do Xingu, indicate that the myths upon which the dances are founded describe the ideal behavior patterns expected of the tribal membership. In cycles that vary from seasonal to as much as 50-year intervals these dances are performed in what appears to be a culture-regulating process whereby the tribesmen instruct and are instructed in correct social and personal behavior by means of their dances. The dances appear to not only reflect time-honored patterns of behavior but are also modified continually to reflect changing conditions and tribal values (Agostinho, 1970).

Other obvious examples of dance being exercised as a control factor of the environment are the rain dances of the Navajo and the Hopi Indians, whose dances have been documented to have effected seemingly miraculous control of the environment (Sachs, 1939). Less obvious but nevertheless effective in regulating and spanning time in real space are all dances that represent individuals, events, objects or states of being that are other than the real time-space events of the dance itself.

THE FEEDBACK THEORY OF THE EVOLUTION OF DANCE

The Primitive Dance of Village Tribesmen

One of the early major cultural developments of man is related to his establishing villages and becoming stationary. Smith (1962) concludes that this development was a predictable development growing out of the improved perception of temporal aspects of seasonal and astronomical changes that could be observed by remaining in one place over a prolonged period. It is thought that this development was closely connected to the clocking activities of the burial rites that characterized earlier periods and levels of developments. It is likely that most villages grew up near tomb sites that incidentally were located by stellar clocking criteria. It is believed that early man settled in one place in part to be by his deceased progenitors and in so doing he gained a sense of time continuity and a connection to past time which in turn is the basis upon which future time is projected. From the vantage point of his village, man began to develop skill in tracking the heavenly bodies.

The dances that characterized early village dwellers certainly had many distinct and varied functions for clocking and symbolizing time. However, it is believed that one of the most important functions of dance among these peoples was served by the many dances which were actually designed as "ethereal dances of stars" as Euripides called them. His comment is in connection with a description of the ancient dances depicted on Achilles' shield in his play Electra. Such dances served as models for tracking celestial bodies in determining time. Dances of this type are multitudinous and probably constitute the major part of the dances of the world (Sachs, 1939).

Other references to the dance scenes portrayed on Achilles' shield (Illiad, 18, lines 590-606) describe definite time tracking dances based on a stellar template (Lawler, 1964). The practice of symbolizing time by performing dance that clocked physical time in nature seems to have been a widely practiced activity among ancient prehistoric men. Sachs (1949) has rightly identified the fact that astral motifs are a dominant feature of almost all so-called primitive dance cultures.

Many of the dances that persist among Stone-Age peoples the world over are strictly regulated in their direction of movement and facing by the stellar events with which they are associated. Examples of this type of dance cited by Sachs (1939) are the Circumcision dances of Central Australia, the Sundances of the Arapaho, and the Mexican Cora dance, all of which are oriented towards sun, moon and star

sightings calculated to telling time. The California Indian dance houses and the dance rings of the Blackfoot Indians open to the east and the rising sun while the mystic Chassidim dance of the Rabbi Lurja Circle alternate standing and moving between west and east before their sabbath.

The Cayapo Indians of Northern Brazil practice a time-regulated dance each month on the day of the new moon. On this occasion, the women carry out a stamping dance that becomes progressively livelier and more excited. When the dance reaches its peak the women light sticks in a fire around which they have been dancing and walk diagonally back to their homes (Sachs, 1939). It is very likely that this dance is simply a calendar-marking dance related to the lunar and menstrual cycles.

The technique known as hocketing as it is used in music and dance activities, in which dancers and players perform in rapid sequential fashion to create a unified form is obviously a timing process. The Greeks are known to have traditionally danced a dance of this sort that symbolized the cycles of the moon. It is a circle dance known as Oklasma or hygra orchesis in which the dancers carried shields in the form of crescents. The dancers sank to their knees one after another and then sequentially rose again representing the phases of the moon (Sachs, 1939).

It is believed that the limping dances that appear in almost every culture are related to symbolizing time as it relates to the seasonal changes connected with stellar events. Sachs (1939) points

out that according to mythological conceptions, limping means "to be still weak, to begin." In Southern Australia, the Aborigines dance a limping dance in which after a short time the limping individual suddenly laughs and vigorously leaps into the air. Sach (1939) explains that this behavior represents the cycles of the moon. Once again to understand the significance of such time symbolizing one must comprehend that for the Aborigine this constitutes the only way of being assured of the continuity and actuality of events that are not actually present.

The practice of symbolizing the rhythms of the heavenly bodies has continued throughout the evolution of man. Sachs (1939) indicates that astral dances appear in almost every culture and he points out that the dancing king, Louis XIV, is better known as the Sun King for the role he is said to have danced in his own court ballets. It also should be noted that Leonardo de Vinci is credited with composing a ballet at the turn of the sixteenth century in which the entire astronomic system was depicted in dance (Sachs, 1939). In present times some of the major art dances of the times are based on stellar motifs. An example is Paul Taylor's ballet called Orbes, which is a straightforward presentation of the interacting planets. That dance has been continually used as a medium for symbolizing time is not coincidental to the fact that from the earliest times dance has in fact been a primary time piece in the evolutionary development of man and his culture.

Further examples of the timing characteristics of tribal man's dances at the level of village cultures are the dances that served to

mark the time between hunting excursions and to recreate the events of past excursions and plot future hunting parties as well. The same can be said of war dances which likewise served to establish the tribesman's sense of past, present and future time. These dances no doubt served other functions as well, one of which was to regulate the physical fitness of the hunter-warriors during their less active village residencies. In this function, dancing acted and still does among current tribal societies, to feedback control and organize the anatomical-physiological, and neural development of the tribesmen by synchronizing the various levels of movement organization and energy production and utilization for more efficient and productive behavior.

Folk Dance Cultures

It must be kept in mind that with each progressive level of dance culture the dance forms of the past levels underlie and are the basis of the new forms. The transitions between the levels that are designated in this theory of the evolution of dance, therefore, are not abrupt but rather develop slowly and smoothly and the older forms continue to be very much a dynamic and ongoing part of the new levels. For this reason it can be expected that dances which typified one level played very critical and important roles in later cultures.

It is believed that the latter part of the development of village societies and the early development of temple societies are characterized by dance forms that have come to be known as folk dance. Folk dances are considered in most traditions to be older than the dance drama forms that have come to be known as ethnic dance. Folk

dances are considered in most traditions to be older than the dance drama forms that are associated with temple societies (Vatsyayan, 1908) and yet they seem to play an important low culture role among the common people of temple societies. It is therefore believed that folk dancing is the product of the village populations that preceded the development of virtually every world culture.

It can be assumed that just as the earlier levels of dance culture defined and were defined by specific levels of time awareness, the folk dances of Mexico, Europe, India, China and the Near East have functioned as ever more complex and elaborate timing mechanisms. Many folk dances are characterized most specifically by little understood excursions into the nature of episodic time. The typical Bulgarian folk dance rhythms consist of mixed meters of 14/16+10/16 and 15/16+9/16 in which the dancers perform intricately timed foot and body patterns. In such dancing it is believed that the dancers function similarly to clocks and through the process of the whole village participating, either as musicians or dancers, everyone so to speak sets their clocks together. An excellent example of the literal symbolism of clocks and clocking time is found in the German folk dance called Sauerlaendler Quadrille in which the dancers play the roles of the animated figurines of a large clock.

It is further known that folk dances universally are connected to calendaring functions in that they are usually specifically designated to specific calendar events and festivals that comprise the cultural fabric and memory of the people the dances help to define.

Folk dances have a large part in regulating and keeping track of the seasonal customs which make up the calendar cycle of each society (Katsarova, 1951).

The Ritual Dance In The Control of Time Cycles of Life and Death

Another vital timing function of dance since the emergence of Homo Erectus and Homo Sapien has been in its close relationship with funeral practices. It is believed by Smith (1962) that early man probably looked upon death as constituting the continuation of life in a death and rejuvenation cycle and therefore engaged in elaborate activities to maintain dead individuals in preparation for future life. These efforts to extend, renew and otherwise control the periodicity of time as it related to life and death followed diverse forms, many of which are alive and act as real factors of modern culture.

Lawler (1964) has noted the references in Greek literature to the armed funeral dances of prehistoric Crete in which the living apparently endeavored to infuse life again into the dead by a display of vigorous and noisy activity. Such activities which are known to have existed in many parts of the world are believed to have been practiced in the epoch of Neanderthal man, around 80,000 B.C. This early, now extinct strain of beings practiced funeral rituals that involved obvious efforts to infuse new life into their dead by painting their corpses to represent lifelike coloring. It may be safely assumed that the dancing or ritualistic movement that accompanied such burial rites was designed to help extend the time of life in the individual.

The mere fact that funeral activities were engaged in by these ancient people is a positive indication that the concept of setting limits to time and symbolizing human events in time was developing. Smith (1962) maintains that early man's concern with controlling human events in time and his techniques for clocking time were closely associated with burial practices, which eventually influenced the course of village patterns and temple building. It is believed that the ritual practices and mechanism of human burial, which included the building of tombs, and the marking of the burial time so that later ceremonials could be scheduled, constituted a significant control of time and its symbolization. It is further held that the ceremonial rituals that accompanied these activities were essential factors in the development and maintenance of that control.

It is thought that the subsequent cultural derivatives of the funeral dances of antiquity constitute many relevant aspects of contemporary culture. The armed funeral dances of the Stone-Age people of Crete are believed to have been the forerunner of the ancient Greek practice of encircling the dead with chariots and men in armor (Illiad 23, 8-41), which eventually led to chariot racing and foot racing among the Greeks in honor of the dead. These activities, of course, later became formalized athletic games and find their place in current society in the form of oval racing tracks where auto racing, horse racing and even human track events take place. It should be noted that the primary focus of the modern day vestiges, or more accurately stated, evolutionary products of prehistoric funeral dances is the relative timing of the participants in the competitive events.

Similar to the funeral dances of Prehistoric Crete, were the burial related blood letting rituals of the Etruscans. These precursors of the later Roman civilization practiced dances in which the living ritualistically spilled each other's blood to provide blood to enervate the dead. This time controlling activity was taken over by the Romans in the form of the deadly gladiator spectacles (Smith, 1962) which also were time significant as a means of marking and observing calendared holidays. Contemporary derivatives of the early Etruscan funeral dances are represented by such spectator sports as football and ice hockey. These modern events have clearly distinguishable time related functions in that they are carefully timed activities, controlled with precision clocks and timing rules. Furthermore, spectator sports serve to define the meaning of leisure time for many individuals.

It is also very likely that the entire ritualistic behavior of modern military organizations has directly descended from the Etruscan funeral dances. The drills and formations of training and displaying a contemporary army, including the ceremonial activities associated with military funerals and ceremonies, have striking similarities that can be assumed to be more than coincidental.

The Dance-Dramas of Temple Societies

Characteristic of every temple society has been the concomitant development of highly articulate dance languages that seemed to have the same time binding function as written languages in the development of an archive of mythological past history. The obvious examples of these elaborate and expressive dance forms are in the dance chorus of

of Greek tragedy and the Indian and Balinese dance dramas that function as chronicles or cultural history dances in giving the people a sure sense of the ongoing nature of life (Lawler, 1964; Vatsyayan, 1968; and de Zoete and Spies, 1939).

The principal characteristic of the dance dramas of most temple societies is the highly developed symbolic use of movement. There is no doubt that the emergence of written language during the development of temple society (Smith, 1962) was closely paralleled by the creation of dance forms that were capable of expressing and communicating the greatest intricacies of narration and thought (Vatsyayan, 1968).

Pronounced evidence in support of this can be found in the dance culture of Bali in which dance has had the same kind of evolutionary influence that languages have had on its people. Among the people of Bali the language of dance has evolved to almost the same level of sophistication as the spoken language and serves as a time-spanning repository of tradition and cultural coherence. Just as the mechanisms of speech and language have become highly specialized in the "talking" species, so the Balinese, as a result of the evolutionary development of the specialized motor-sensory and anatomical mechanisms required in their complex and articulate dance behavior have developed pronounced behavioral and anatomical traits related to their dances (de Zoete and Spies, 1939). The capability of these people to distinguish and attach specific significance to an almost infinite variety of symbolic dance movements comprising numerous distinct dance forms is comparable to the discernment and articulative skill called for in the complex requirements of formalized verbal languages.

In the temple or classical dance of India the motion of the body seems to have been thoroughly analyzed and names were given to each movement. For example, the seven possible movements of the eyebrow and the nine possible movements of the eyelid were named and served as expressive components of a complex movement language. It is believed that in order to fully understand the evolutionary development and the mechanisms of the control of the articulated movement that comprise dances of this order, a systems analysis method must be employed. The feedback theory of behavior analysis constitutes a method whereby these highly developed dance languages of the temple societies must eventually be examined.

The theme of time is just as prominent in temple dances as it has been shown to be in all previous dance cultures. Vatsyayan (1968) points out that the Indian dancer's greatest preoccupation is not with utilizing space but rather the dancer is constantly trying to achieve the perfect pose which will convey a sense of timelessness. Likewise, the form and content of highly developed temple dances of Meso-America all seemed to be determined by efforts to express concepts of time and its continuity (Weaver, 1970). These highly developed dances of early temple societies formed the basis of religious ritual and determined the fundamental worship patterns which have persisted in time as the transformed behavior that constitutes the framework of contemporary religious liturgy (Oesterley, 1923). A cybernetic analysis of most contemporary religious practices would reveal to what extent religious temple dances have determined the form of modern religion.

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Spectator Dances of the Mercantile City

The cybernetic theory of dance evolution being developed here holds that the advent of spectator dance is closely related to the emergence of the mercantile city societies and that the change from dancing as participative general activity for all members of the society to specialized performance activities can be explained by the mechanism of slavery and its role in determining the nature of mercantilism. Smith (1962) provides convincing evidence that slavery has formed the economic basis of the latter part of most temple societies and eventually served as the prototype of all forms of productive enterprise and exchange. The fact that slaves acted in the role of specialized dancers is attested to from as far back in history as ancient Minoan Crete (Lawler, 1964) where both slave girls and young men performed a hazardous form of acrobatic bull-play for the amusement and spectacle of the king and his invited guests. There seems to be a pattern of specialized spectator-oriented dance forms and practices that parallels the establishment of cities and their concomitant activities of mercantilism which until only relatively recently have been based on owning slaves and engaging in modes of exchange that were based on slaves as the legal tender.

In order to improve their value the slaves were educated by their masters and many of them were trained as entertainers. The level of training of these slaves is attested to in the murals, statues and vase paintings from all over the classical world as well as in Egypt and Central America.

Pageants

The huge court and city pageants of Europe that can be dated from the late 1300s represent a short step from the Roman circuses. These early Renaissance extravaganzas did not consist of gladiatorial bloodshed but they were staged for the population and had many characteristics, such as the novelty of events and activities that were important features of their Roman counterparts. These spectator oriented events included equestrian spectacles, parades and large scale combat activities. They were motivated by similar objectives which were to win favor and gain appeasement from a restless lower class as well as to impress the world with newly-attained wealth. These precursors of classical ballet were also similar to the Roman entertainment in that they were purchased just as surely as the talent for the Circus Maximus was bought. Unlike the gladiators of Rome, the performers in the pageants of the emerging mercantile society of Europe were not slaves but rather paid professional entertainers. The wage was often the privilege of keeping the costume used in the event.

The form and content of these large public pageants often revolved around the portrayal of mythological events and historical representations as well as purely entertaining dynamic geometric designs. The function of symbolic representation of past events in establishing a sense of time should by now be quite obvious to the reader; however, the purely geometric moving patterns represent a concept of time that has not been discussed. It is believed that the

designs represented the expression of a developing sense of space-time interaction.

It was during the same period of the practice of the spectacles described above that the first workable clocks were being introduced and developed in Europe (Goudsmit and Claiborne, 1966). It is appropriate to assume according to feedback principles of evolution of culture that these two facts are significantly related since it is held in this theory that culture and tool-using comprise a feedback controlled closed loop system.

Ballet

The development of the classical ballet is dated from a wedding pageant in 1581 that was organized in honor of the royal family of Henry III of France. It was called the "Ballet Comique de la Reine" and is said to have cost almost a million crowns to produce. This first ballet differed from the earlier pageants and games from which it was derived only in that the various events were time organized to convey a coherent and sequential series of dramatic ideas.

Beyond its temporally significant organization, ballet has numerous other temporal functions. The fact that the development of spectator oriented dances in most instances has been closely related to the emergence of a population of newly-made rich is by no means a coincidence. In the case of the dance culture of Renaissance Europe, it is believed that the development of ballet can be explained in terms of feedback interaction of leisure time factors

among significant numbers of wealthy individuals. It is expected that future systems analysis of ballet dance culture will more specifically identify its time functions in relation to culture as a whole.

The Social Dances of the Factory-Organized Society

In the theory being presented here, it is believed that social dances in which partners of the opposite sex dance together are closely related to the timing level represented by societies that are organized according to principles of manufacturing and factory operation. The fact that partner dances which meet the criteria of being social dances are known to antedate what is traditionally considered to be the beginning of the Industrial Revolution and the beginning of factory-ordered society does not invalidate the assumption that social dance is associated with the cultural level of timing related to factories and industry since as Smith (1962) points out, early precursors to industrial developments are as ancient as the textile industries of Tuscany.

While conclusive data does not presently exist to fully support the assertion that social dances are directly related to industrial societies, the weight of cybernetic rationale pointing to the plausibility of the idea would indicate the need for further investigation along these lines.

Dances of the Mass Culture of International Industrialization

While the subjective nearness of the development of a mass culture through the timing devices of modern world-spanning communication,

and more specifically the timing processes of computer technology, may make it difficult to identify their related manifestations in dance, it is believed that some general observations can be made about contemporary dance and its timing role in the recent past as well as in the ongoing evolution of culture. First, it is relatively clear that the development of the phenomena of modern dance has been basically a nationalistic movement closely tied to the national industrial patterns that constituted the foremost level of time organized culture. In support of this assumption is the fact that a parallel modern dance form developed in Germany concomitant to the emergence of the American modern dance. Both of these forms have been extremely nationalistic and their rise and fall have coincided with the rise and fall of purely nationalistic industrial practices.

The second observation is that contemporary dance culture, just as those of the past, is comprised of all the dance forms of the past. Each of these forms is continuously evolving at the present time at its own pace as determined by the nature of the time perception with which it is associated. Not only are the various levels differentiated, but they are also integrated with each other through dynamic feedback regulated interaction. This accounts for the fact that much of the visual aesthetics of the older ballet can be found in the newer modern dance forms and that folk dances, primitive dances, social dances and the ethnic dance-dramas originally associated with temple societies coexist side by side and are known to borrow from each other in the process of their ongoing evolution.

This explanation of what has traditionally been understood as a process of cross culturalization (Sachs, and Hornbostel, 1933) goes beyond the limited assumption that cultural change is merely an admixing of adjacent cultures. The cybernetic interpretation of the progressively increasing complexity of culture and of dance as a manifestation, as well as a controller of that culture, is that each new cultural pattern or dance form is an evolutionary development related to man's expanding consciousness of time.

It is held that as a new level of behavior emerges, it modifies but does not replace the older, less time sensitive dance form as the primary art form of its time. There is usually a certain amount of friction associated with the emergence of a new dance form as obviated by the general animosity that existed until only recently between the balletomanes and the modern dance enthusiasts over the value of each other's favorite dance forms. In the late 1960s and going into the 1970s it can be noted that the friction between the advocates of ballet and modern dance subsided and was replaced by a similar aura of distrust and sometimes even outrage between modern dancers and the so-called avant-garde dance people. This is probably due to the fact that modern dance had ascended to the first order of cultural evolution by the sixties and had successfully integrated many of the relevant aspects of ballet into its form. Instead of being the challenging new art form containing an advanced insight into the nature of time, in the sixties, modern dance was being challenged by dances that were based in visions of qualities of time that were related to the ever-accelerating contemporary world.

The so called avant-garde dance and music of the "sixties" and those of the "seventies" often manifest qualities of time by the breaking of sequence and suspension of meter. The introduction of "other time" and "present time" from various viewpoints synonomously as well as sequentially also characterize many of these dances. It is believed that many contemporary dances can only be understood in terms of what they are expressing about heretofore unfamiliar aspects of time. Cage (1961) clearly asserts that shifts in the perceptions of qualities of time are at the root of contemporary music trends.

Predictions of the Evolutionary Course of Dance

It is fully expected that just as the dance forms of the past have functioned as both expressions of the level of man's conceptual ability to understand the dimensionalities of time and as an important force in the development of those levels of temporal understanding, dance in the future will continue to function similarly. It is also reasonable to believe that the dances associated with past levels of culture will persist and continue to evolve at their characteristic paces. Furthermore, as in all other times, the older dances will be dominated and integrated with each other in time through feedback regulated interactions with the foremost dance form representing the most advanced timing function. The continued enrichment and ever greater complexity of design and process can be assured for the future.

CHAPTER IV

SUMMARY

The dilemma posed for the study of dance as a cultural phenomena is that past theories of behavior and psychology have been limited in explaining dance motion as the dancer knows it and controls its course. This thesis presented some new ideas regarding a feedback or systems theory of dance behavior and summarized historical and evolutionary evidence to support some of the assumptions of the theory.

In the second chapter the main ideas of behavioral feedback theory were used to explain and describe how an individual imparts organized continuity to dance motions and their sensory and neural feedback processes. It was indicated that the dancer organizes, continuously controls, guides, times, and regulates the force and expression of dance motions through self-governed, motor-controlled, feedback processes between active movements and their sensory results.

It was further pointed out that guidance or control of behavior and hence of dance motions is determined by a process in which one part of the body tracks the sensory effects of another moving part so that the dancer guides himself in the time, space and force aspects of motion by means of reciprocal interplay of different movements. This body tracking theory contrasts sharply with past stimulus-response and mental volitional theories in that it assumes that all

parts of the behaving system are mutually responsible for the organization and guidance of movement.

The social aspects and determination of dance motion also were described in the second chapter. It was stated that social interaction in partner and group dancing is determined by cross linking of the motor and sensory systems of the interacting dancers in a feedback relationship so that the movements of one partner generate sensory effects which can be controlled as feedback by movements of the second and vice versa. This theory of social feedback control in partner and group dancing has a special distinction in that it gives an account of all of the manifold patterns of social behavior of the dance in terms of observable modes and conditions of positive and negative parallel and series linked social tracking.

The systematic nature of behavior indicated by a behavioral and social feedback theory of dance motion can be substantiated by experimental results regarding feedback of motion. It is also possible, as is done in this thesis, to substantiate the feedback theory of dance motion by assembling evidence regarding feedback and cybernetic properties of the evolution of past dance forms. The third chapter attempts to evaluate the theory of feedback control and organization of dance behavior, as presented in the second chapter by pointing up the cybernetic and feedback features of past dance forms and the feedback effects of dance behavior on social adjustment. Critical facts were presented that dance behavior has evolved as a type of ritual and activity scheduling process that serves to span time and to aid in temporal perception.

In the present view cultural manifestations of dancing serve not only to orient its participants to week, day and seasonal time, but to symbolize life functions and activities in a temporal context. The theory and the historical evidence indicate that dance behavior has critical roles in contemporary society. It also systematically projects future social interactions of the society.

This study has pointed to the feasibility of applying systems theory to the study of dance and its role in culture. It is hoped that further studies in specific areas of the field of dance will substantiate and expand upon the theories and assumptions indicated here. The possibilities for developing sound technical as well as educational principles from which to operate in the field of dance have been demonstrated in this study. This behavioral cybernetic interpretation of dance and dance culture may serve as a starting point for developing these principles.

The overall theme of this thesis is that the theory of dance behavior should encompass more than an account of the causes and determinations of dance motions by external events or by processes within the dancer himself. Specifically, it should encompass an explanation of the reciprocal or feedback effects of dance behavior and performance, not only on the dancer and his activities, perceptions, and physiology, but on the society and culture in which the dance has evolved both as a form of motion and as a non-verbal language and time-oriented expression. The theory proposed here is that these individual and cultural feedback effects of organized dance motions

are what makes dance forms presisting expressions of both art and common social interaction. The thesis has suggested that these feedback effects of dance motion on individuals and culture are possible because dance behavior in both its detail and overall organized expression is determined as a motor-sensory feedback process. The evidence for feedback effects of dance behavior on individuals, culture and human evolution is direct evidence that at its most fundamental behavioral and physiological basis, dance motion is also feedback controlled and cybernetically regulated.

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TITLE OF THESIS A BEHAVIORAL CYBERNETIC INTERPRETATION OF DANCE
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