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IMPLICIT KNOWLEDGE OF MOVEMENT INTELLIGENCE

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled IMPLICIT KNOWLEDGE OF MOVEMENT INTELLIGENCE submitted by MARGARET JANE TAYLOR in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Physical Education.

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Date: May 25, 1989

To My Parents

This thesis is dedicated to my parents, Dorothy and Ted (Theodore) Clarke, whose belief that you can do anything you put your mind to, became a legacy for which I will always be grateful.

ABSTRACT

The purpose of the present study was to isolate and analyze declarative knowledge of skilled behaviour to determine if differences exist at the implicit level between skilled and unskilled performers. Comparisons were also entertained on self ratings of three elements of movement intelligence. Since it was assumed that performance skill develops with the growth of procedural, declarative and affective knowledge, an attempt was made to categorize the knowledge generated into these different domains. In addition, a similar analysis was conducted on implicit knowledge of the characteristics of unskilled behaviour.

Four groups of subjects, totalling 243 people aged 11 to 60 were asked to record the characteristics which they felt typified skilled and unskilled behaviour. The groups represented library users, physical education majors, novice jazz dancers, and expert jazz dancers. An equal number of subjects from each group listed the characteristics of either a skilled athlete, a skilled dancer, a person who moves well, or a person who is unskilled at movement. All subjects also rated their own athletic, dancing and movement ability on a 9-point scale. All behaviours were coded by independent observers in order to create master lists of skilled and unskilled behaviour characteristics. Consistency was further documented by having 26 percent of the data in these master lists coded by 3 independent research assistants. Average agreement scores were 80 percent for skilled and 96 percent for unskilled behaviours.

Results of the study indicated that implicit knowledge of skilled and unskilled behaviour could be demonstrated. In addition, all four groups novice and expert dancers, physical education students and library users believed that skilled behaviour was characterized by grace, confidence, coordination, and

rhythmical movement, whereas, unskilled performers were felt to be awkward, unsure and uncoordinated. In contrast, expert dancers ranked themselves much higher in dance skill level than any other group, and with physical education majors perceived their movement skill as higher than both novice dancers and library users. All groups depicted similar patterns of relationship between the three elements of movement intelligence- everyday movement skill, sport skill, and dance skill.

Both factor analyses and clustering techniques effectively isolated the procedural knowledge component in the skilled data, whereas the metacognitive and affective domains were evident but interactive. It was hypothesized by the writer that the implicit knowledge illustrated in this study was well developed or automatic metacognitive knowledge which has an important role in the development of skilled behaviour. Similar, but less clearly interpretable results were obtained from analysis of the unskilled data. The interactive nature of the affective and metacognitive components of implicit knowledge does not deny the possibility of demonstrating uniqueness in either learning or action situations. In proposing that implicit knowledge is automatized metacognitive knowledge, the need for developmental studies which document not only existing levels of knowledge, but also changing levels of knowledge within specific sport and daily movement contexts was recognized.

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CHAPTER I

INTRODUCTION

Theoretical research is not unlike the world of pop music. Just as there has been a tendency to switch from one form of musical expression to another, there has been a history of movement from one mode of scientific inquiry to another. As quickly as new theories develop there seem to be researchers ready to try and solve the riddle of human behaviour from a different point of view. However, existing schools of research seem to last longer than their musical counterparts, and continue to claim and retain advocates in the scientific community. A quick perusal of the past 100 years will reveal the rise and fall of functionalism, behaviourism, Gestaltism and genetic epistemology to name but a few of the major modes of inquiry.

Since 1950 there has been a steady growth in the development of the *cognitive tradition* in psychology. Cognitive scientists are particularly interested in the nature of knowledge - its components, sources, development, and use (Gardner, 1985). They have been directly influenced by the advent of artificial intelligence, computer technology and the drive to build an expert system. Although much of the initial research by cognitivists was purposefully isolated from biological, affective and contextual influences, the interdisciplinary nature of cognitive scientists themselves has prompted a move to unite the psychological and the physiological, or at the very least to accept the existence of both (Kandel & Schwartz, 1985; Gardner, 1983).

The growth of the cognitive science tradition has not gone unnoticed in the field of motor development research. In fact, the recent work in information processing (Rumelhart & Ortony, 1977), memory and metamemory (Flavell & Wellman, 1977), and strategic and problem solving behaviour (Chi, 1978) has been mirrored quite nicely. The motor domain can boast Schmidt's schema theory (1975), work on recall of sport specific information (Chiesi, Spilich, & Voss, 1979), and the recent work on recall and strategy production in field hockey experts (Starkes,1987), and basketball players (French & Thomas, 1987).

Just as psychologists have shown their dissatisfaction with the limitations of existing theories of behaviour, recent attempts to detail motor skill acquisition have sought a broader based explanation. Thus in an attempt to overcome the inability of information processing models to explain or at least encompass the problems of storage, retrieval, individual differences in learning rate and performance level, and influence of context, motivation and experience, a more holistic or knowledge-based approach has been proposed (Newell & Barclay, 1982; Wall, McClements, Bouffard, Findlay, & Taylor, 1985).

At the heart of this inquiry into the development of skilled behaviour is the belief that knowledge in any particular domain relies on the inherited structural capacity of the organism and the acquisition and interaction of three distinct yet compatible cognitive bases; that is, declarative, procedural, and affective knowledge (Wall et al., 1985). Briefly, declarative knowledge is the representation that people have about something, and includes the memory of facts as well as the knowledge that a person has about his or her own "cognitive resources and the compatibility between himself as a learner and the learning situation" (Brown & Campione, 1981, p. 521). On the other hand, skills, rules, algorithms, heuristics, procedures and plans comprise what can be termed the procedural knowledge cluster. The third major cognitive base, affective knowledge, involves the subjective feelings and resulting motivations that accumulate each time people perform a particular action in a specific context. The development and interaction of these three knowledge bases contribute to and allow for the effective use of such higher cognitive activities or metacognitive skills as checking, monitoring, testing, planning, revising, and evaluating one's actions (Brown & Campione, 1981; Wall et al., 1985).

The beauty of a knowledge based approach lies in its acceptance of the complexity and power of the human system; the development of separate, definable knowledge bases; and the requirement that these bases integrate in the daily learning and performance of the individual. Guided by this model a number of recent studies have been conducted. They have ranged from the exploration of the application of metacognitive knowledge by mentally handicapped adolescents in a table tennis task (Bouffard, 1986); to a study of developmental differences in declarative, procedural and metacognitive knowledge when applied to a simple aiming task (Findlay, 1986); and the effect of instruction on the tracking performance of children with high and low procedural knowledge (Koutsouki-Koskina, 1986). All of these studies are important because they broke initial ground in attempting to apply the concepts inherent in a knowledge-based approach to skill acquisition.

The Problem

Although such a knowledge-based model has proven to be an exciting combination of the strengths of both biological and psychological theories, it has by no means answered all of our questions about skill development. Indeed, we are often still at the point where we sometimes have to accept some of its tenets because we *believe* them to be true. As Thomas explains, this is a logical first step or consequence in the process of theory building (1979). To be fair, it has frequently been stated that a knowledge-based approach is not a formal theory, but a broad based conceptual framework from which to direct our inquiries into motor development (Newell & Barclay, 1982; Wall et al., 1985). Perhaps researchers have been asking too much of the Wall model in its present form when they have attempted to explain or predict behaviour according to its guidelines (Bouffard, 1986; Findlay, 1986; Koutsouki-Koskina, 1986; Marchiori, 1987). Not only have they been forced to assume that each of the different knowledge bases exist, but also that each can be experimentally tapped and illustrated by their subjects when attempting to solve the particular problem which is presented to them.

In fact, we are beginning to see more and more the admonition that representation of knowledge in the motor domain may be quite different from the constructs believed to be operating in the solving of the chess, physics or reading problems which have provided much of the evidence for existing knowledge bases. In addition to the unarguable observation that the nature of the above problem solving tasks is considerably different from what one meets in the physical world (Reid, 1986), one cannot escape the complaint of Whiting (1982) that *knowledge how* does not necessarily presume *knowledge that*. In fact, Newell and Barclay (1982) point out that much of our knowledge about action is apparently tacit and perhaps untappable. Rather than assuming that a particular type of knowledge exists and explains the difference between performances of skilled and less skilled actors, there is a definite need to first produce evidence of the existence of a particular type of knowledge at all.

It was in attempting to come to terms with this problem that the present study evolved. The process follows rather closely the four phases described by Thomas in his explanation of theory building (1979, p. 15). It is important to establish at this point that the terms model and theory will be used synonymously in the broad sense that they are an explanation of how the facts fit together, which ones are most important for our understanding of motor development, and which relationships produce this understanding. As illustrated in Table 1, once we have established the basic assumptions on which the model is based and defined the important terms, it is necessary to develop an hypothesis whose validity can be examined or tested by evaluation of the evidence or data gathered.

Table 1

Steps in Theory Building

	Phase 1	Phase 2	Phase 3	Phase 4
	Foundation Convictions	Model Descriptions	Logical Deductions	Conclusions
Products of the Phase	Axioms, Postulates, Assumptions	Structure System	Hypotheses	Principles, Laws
Theorist's Behaviour	Accepts beliefs as self-evident	Defines parts of model and their interrelations	Suggests relationship or outcomes expected if model actully describes development	Generalizes from data to estimate accuracy of model

(Although the process of theory building can thus be described as four sequential steps or phases, in practice a theorist frequently may not move systematically through the sequence. More often than not, theorists appear to shuttle back and forth among the phases, revising here and altering there, to produce a scheme they believe provides a convincing interpretation of the facts.)

(Adapted from Thomas, 1979, p. 15)

If the data do not illustrate the expected outcomes, then theorists continue to evaluate and revise their guiding beliefs in order to produce an explanation or prediction of human behaviour which is more clear, accurate, and internally consistent. In examining the knowledge based model (Wall et al., 1985) it appears that, in striving to devise a theory which would account for individual differences in skill development in the extreme, there has been real difficulty in predicting motor behaviour in general. In addition, although there is a definite assumption that domain specific knowledge varies in level and rate of development in each individual, firm data based on the present model from which this conclusion can be drawn do not exist. Lastly, and perhaps most importantly, the necessity that the three knowledge bases interact as the basis of skill development makes their experimental separation extremely difficult and arbitrary. These foregoing concerns prompted the writer to incorporate the work of Gardner (1985) and Sternberg (1981) into the framework of this investigation in the hope of gaining a clearer understanding of the nature and role of declarative knowledge in the development of skilled behaviour.

Theories of Multiple Intelligences

The recent writings of Gardner (1983; 1985) have provided an excellent link between knowledge-based research in cognitive psychology and motor development. Gardner has developed a theory of multiple intelligences or a modular view of cognition in which he delineates seven distinct abilities that permit an individual to solve problems of consequence in a particular culture. In Gardner's view, every individual develops musical, bodily kinaesthetic, logical mathematical, linguistic, spatial, inter- and intra-personal intelligence to some degree. Each of these distinct systems develop and operate somewhat differently and separately depending on the content which is being manipulated. Gardner postulates that bodily or kinaesthetic intelligence, "the ability to use one's body in highly differentiated and skilled ways for expressive as well as goal directed purposes...and to handle objects skillfully" (p. 206), is the quality possessed by good dancers, swimmers, artisans, and ball players, for example.

Although Gardner has taken a modular view of intelligence he definitely agrees that people benefit from and require the overlapping of skills in different areas. He adopted this approach because of his dissatisfaction with accounts of intelligent functioning which relied on the existence of general intelligence or *g*, but were relatively inadequate in explaining individual differences in domain specific knowledge. Gardner feels that the concept of multiple intelligences more adequately reflects the data of human intellectual behaviour, or what is successful in the real world.

A more formal but still complimentary approach is put forward by Sternberg (1985) in his triarchic theory of intelligence which comprises three subtheories. The first, or componential part, relates intelligence to the internal world of the individual, and specifies three kinds of information processing components that are necessary to learning, planning and doing. These components closely resemble the procedural, declarative and metacognitive knowledge bases illustrated in the memory literature by Flavell and Wellman (1977), and Brown (1977; 1978) and applied to the motor skills domain.by Newell and Barclay (1982) and Wall et al. (1985). The second subtheory specifies the importance of the ability to automatize and to deal with novelty. The third subtheory relates to everyday intelligence in the external world of the individual and requires environmental adaptation, selection and shaping.

Both theories have a view of what can be termed generally intelligent behaviour, but take into account the natural individual differences that allow for excellence in a particular domain. Both theories are an attempt to address the questions of intelligence not only in the minds of the individual, but also as they apply to tasks in the real world. They have an inherent attractiveness which does not often accompany theoretical work. The addition of both of these aspects to the knowledge based model was immediately appealing. It seemed a logical step to borrow from Sternberg's idea that intelligence is both universal and particularistic and conceive of both a componential (knowledge based) and contextual (environmental) view of skilled behaviour.

The incorporation of these ideas therefore prompted the writer to coin the term movement intelligence for the purposes of this investigation. Movement intelligence comprises three aspects: the particular skill required to adapt to many sport situations which will be exemplified by athletic ability; practical or everyday skill which will be illustrated by the ability to move well; and domain specific skill which will be represented by dancing ability for this study. The underlying aim of the study was to increase our awareness and understanding of the role of declarative knowledge in the development of skilled behaviour and in so doing encourage movement beyond Thomas' first phase of theory building (1979).

A New Approach to the Knowledge Definition Problem

Since it was important to add to our knowledge about skilled behaviour without preconceived notions of what it entailed, a new approach to the problem was warranted. Sternberg, Conway, Ketron, and Bernstein (1981) provided an interesting if unorthodox manner of seeking confirmation of explicit theoretical assumptions by conducting implicit knowledge research. Implicit theories of knowledge are informal constructions which already exist in the minds of people. According to Sternberg "implicit theoretical analysis has some of its greatest uses during the early stages of research into a given phenomenon" (1986, p.4). Investigations of implicit knowledge can often provide a new approach to an old problem, or shed light on faulty explicit theories, and may suggest aspects of behaviour that have often been previously overlooked. If the construct *movement intelligence* actually exists in the real world then, according to Sternberg's theory we should be able to find evidence of it in the minds of people.

This approach will not go beyond the exploratory nature of previous studies, however the aim is to add to our understanding of declarative knowledge by introducing a less traditional and encumbered mode of inquiry so that future studies will be able to proceed in a more assured manner. In adapting some of Sternberg's early methodology an attempt was made to determine if people in general have implicit knowledge of movement intelligence. The methodology follows Sternberg's initial series of experiments outlined in *People's conceptions of intelligence* (1981) and the first series outlined in *Implicit theories* (1986).

Four groups of subjects, totalling 243 people aged 11 to 60 were asked to record the behaviours which they felt characterized skilled and unskilled behaviour. The groups represented lay people (library users), athletes (physical education majors), novice dancers (less than 5 years experience) and expert dancers (more than 5 years experience). It should be pointed out that expertise and experience are not necessarily equated, but in this study years of experience was one way of defining the dance groups. Each subject was instructed to answer only one of the following questions. What are the characteristics of a skilled athlete? What are the characteristics of a person who moves well? What are the characteristics of a skilled dancer? What are the characteristics of a person unskilled at movement? All subjects were then asked to rate themselves on their own athletic, dancing and movement ability.

The Questions

The above paradigm was designed to address the series of questions which follows. The initial, and most crucial of these questions sets the stage for the entire inquiry.

1. Is it possible to demonstrate implicit knowledge of the characteristics of skilled behaviour?

That is, if we accept that implicit knowledge comprises generally held, informal beliefs, can we pose questions which will illustrate these beliefs? In order to meet the criteria of acceptance, the questions must be quickly understood or require little if any explanation, evoke immediate responses which are provided with considerable ease and tend to be views which are held in common. If these three initial conditions can be satisfied, it will be possible to compile a master list of behaviour characteristics that represents this implicit knowledge and will provide the basis for analysis in answering these additional research questions.

2.(a) What is the nature of the implicit knowledge of skilled and unskilled behaviour sampled in this particular study?

If the assumption can be made that there are some common views of those behaviours demonstrated by skilled performers then it should be possible to identify those behaviours and the ones that are identified most frequently. Of considerable interest here will be the relationship of group membership (library user, physical education major, novice dancer and expert dancer) and choice of behaviours. It should be possible to analyze this relationship for the characteristics of both skilled and unskilled behaviour. In addition, it will be interesting to examine the concept of movement intelligence by attempting to answer the following.

(b) What is the contribution of each of the components of movement intelligence (athletic skill, domain specific or dancing skill, and movement skill) to the concept of skilled behaviour?

(c) How do the relationships of these components of movement intelligence (athletic, dancing and movement skill) change according to group membership (library users, physical education majors, novice dancers and expert dancers)?

Another aspect of the investigation which should shed some light on the uniqueness of implicit knowledge can be afforded by the ratings of each subject on his or her own skill level. If implicit and metacognitive knowledge are indeed recognizable phenomena, and the subject groups are distinct, then their self ratings should reflect these differences.

(d) What is the relationship of group membership to self ratings on athletic skill, dancing skill and movement skill?

The final area of interest concerns the relationship of people's conceptions of movement intelligence, and the knowledge bases identified. How does implicit knowledge fit into the definition of acquired knowledge in the procedural, declarative and affective domains? In order to shed some light on the structure of implicit knowledge it will be necessary to try to determine the following:

3.(a) How does the implicit knowledge of skill generated in this study compare to the acquired knowledge bases outlined in the Wall model?

(b) What is the relationship between the definitions of skilled and unskilled behaviour and the knowledge bases identified by the model?

Definitions

Declarative Knowledge: refers to factual, movement-relevant information about the self, others and physical objects within the environment which influence every movement and choice of action one makes. Since declarative knowledge, by its definition, is stored information about skill, it is most often illustrated through verbal comment or report. In this study, declarative knowledge is represented by the behaviour characteristics listed by each subject in answering a question on skilled behaviour.

Procedural Knowledge: about action underlies all aspects of an action including the perceptual, cognitive, response initiation, and execution phases. An action sequence includes both the internal processing and the overt behavioural response. Once procedural knowledge has become automatized, its presence is detected by observation or formal measurement of a specific performance. Critical components of a performance, such as speed or flexibility, for example, may also be measurable, but often the interaction of a number of these elements in a complex way produces the visible evidence of procedural knowledge.

Affective Knowledge: refers to the subjective feelings of competence and confidence that develop surrounding every skill that a person has the opportunity to learn and practice. The common course of development would involve some uncertainty and limited confidence as the skill is being learned. As more success experiences develop feelings of competence, the cumulative effects eventually result in a positive physical self-concept Affective knowledge is domain specific, that is, it is possible to develop feelings of movement confidence in some skills but have quite negative feelings resulting from poor performances in other domains.

Metacognitive Knowledge: refers to understanding skills in relationship to the demands of the task at hand. Metacognitive knowledge allows a problem to be assessed, possible solutions to be planned, and the subsequent monitoring of results to take place so that further successful adaptations in performance can be made. Successful application of metacognitive knowledge allows for increased automatization and reduces the need for conscious control of action.

Implicit Knowledge: refers to informal beliefs concerning the characteristics of skilled behaviour which are largely untaught and frequently unspoken, and generally held in common. In this study, implicit knowledge is represented by the behaviour characteristics believed to be present in skilled performers that have been listed by each subject with relative ease and speed.

Movement Intelligence: in this study comprises three components- athletic ability, ability to move well, and domain specific skill. In this study the domain specific skill is dancing ability. As components of movement intelligence, each one contributes to the whole in a slightly different, but compatible way and the relative contribution will vary according to the person or group described in a particular movement context.

Limitations

The study is limited to the extent that:

1. The data gathered are a type of verbal report generated by the subjects and presumed to represent their implicit conceptions of skilled behaviour and of course, affected by their motivation to do so (Ericsson & Simon, 1980).

2. The domain of the inquiry is limited. Generalizations could not be made to other specific sport fields.

3. There can be no assumption made that the behaviour characteristics generated are actually those which are in play during a movement situation.

Delimitations

Subjects in the study were library users, physical education majors, novice and expert jazz dancers.

CHAPTER II

A SELECTED REVIEW OF THE LITERATURE

Knowledge-Based Research

The following review outlines some of the major concerns which have prompted and actually necessitated this unusual inquiry into the nature of declarative or implicit knowledge of skilled behaviour.

> The boundary between behaviour and biology is arbitrary and changing. It has been imposed not by the natural contours of the disciplines, but by lack of knowledge. As our knowledge expands, the biological disciplines will merge at certain points, and it is at these points of merger that our understanding of mentation will rest on particularly secure ground.....The merger of biology and cognitive psychology is more than a merger of methods and concepts. Ultimately, the joining of these two disciplines represents the emerging conviction that a coherent and biologically unified description of mentation is possible. (Kandel & Schwartz, 1985, p.832).

The development of a knowledge-based model of motor skill acquisition (Newell & Barclay, 1982; Wall et al., 1985) was in part a response to this need to find a more complete explanation of behaviour from both the biological and psychological perspectives. Skilled performers display four major characteristics that allow them to predict, plan and execute movement in response to environmental changes. Motor constancy allows a person to generate a number of movements which serve the same or related purpose, but call upon different muscle groups. Even when movement patterns are well developed, there is still a bandwidth of variability that makes each trial unique. However, the more skilled the performer, the more consistent the performance and therefore the greater the chance of modifying a response to suit the need of the moment (Glencross, 1982).

The schema has generally been accepted in the motor skill literature as the structure of knowledge which allows such flexibility in the human system (Schmidt, 1975; Newell & Barclay, 1982). The knowledge based model has taken knowledge representation a step further by insisting that schemata are not only the active products of organism-environment interaction, but also the processing rules for understanding and reacting in future performances (Wall et al., 1985). Therefore, the acquisition and representation of knowledge are interdependent complementary processes (Newell & Barclay, 1982).

The interplay between the top down, knowledge to action, and bottom up, perception to knowledge development is well depicted in Norman and Shallice's description of action schemas (1980; Wall et al., 1985). In their metaphor depicting the psychological processes involved in attentional control (vertical threads) and automatized action (horizontal threads), a plausible description of the developing action system is provided. Speed and accuracy of processing information depends then on the ability to activate previously stored packets of knowledge with as little deliberate control as possible.

Despite this initial emphasis on the identification of the processes involved in performing tasks, a switch to the importance of the organization and representation of the knowledge itself took place rather rapidly with the work of Chase and Simon (1973). They found that expert and novice chess players did not differ in their processes of playing chess, but in the knowledge bases upon which they could successfully draw. Since processing speed definitely has upper limits, the essential ingredient in intelligent performance seems to be the organization of knowledge in a way that makes it highly accessible and conveniently usable. The Wall et al. model (1985) has recognized the importance of knowledge development in skilled action and in assimilating the work of Anderson (1982), Flavell (1977), Brown (1978), and Newell and Barclay

(1982) has attempted to give further definition to three distinct domains of knowledge which interact and are an essential part of this development.

Procedural knowledge relates directly to the storage of action schemas that control the execution of skilled action. Schemas are active units of knowledge that store information in a generalized manner in order to account for flexible use of large amounts of information (Wall, 1986). Declarative knowledge refers to factual, movement-relevant information about the self, others and physical objects within the environment which influence every movement and choice of action we make. Intimately connected to declarative knowledge, is the symbol system, or language which we use to describe and conceive of our actions. In information processing terms we can think of procedural knowledge as the bottom-up or molecular aspect of skill acquisition and declarative knowledge as the top-down or molar aspect of the same.

It is in highlighting affective knowledge, that the Wall model departs from earlier views of motor skill acquisition. Affective knowledge, the third type that develops, involves the subjective feelings that people store about themselves in various action situations. As a result of the number of successful encounters with the environment that one has, a certain degree of movement competence develops This level of competence will directly influence the feelings of confidence that one has in meeting challenging or even every day movement situations (Keogh & Griffin, 1982).

The interaction of these three knowledge bases and in particular the development of the affective component allow for the development of a higher level of control, through the activation of metacognitive skills. Metacognitive skills include execution of effective strategies for planning, monitoring, checking, testing, and revising of one's actions in order to meet the demands of novel or difficult situations. Metacognitive knowledge involves the awareness of all of these strategies and the ability to verbalize them, as a coach would do. It does not include the execution of these skills.

Many studies have been conducted in the field of psychology which illustrate the increase of metacognitive skills with age (Brown, 1975, 1977, 1978; Flavell, 1976; Flavell & Wellman, 1977). Research illustrating this phenomenon in the motor domain is less evident. Although recent attempts to apply the guidelines of a knowledge-based model have shown some promise, they have also illustrated some of the difficulties which traditionally accompany this type of inquiry.

Gardner captures one of the salient problems of knowledge based research with this statement:

> Cognitive science is predicated on the belief that it is legitimate - in fact necessary to posit a separate level of analysis, which can be called the "level of representation" (1985, p.38).

Researchers have used the terms symbols, rules, images, schemas, and ideas to describe how information is represented, but generally they are attempting to characterize "the stuff" between input and output. Representational analysis studies the ways in which these entities are joined, transferred, or contrasted with one another. This level is necessary in order to explain the variety of human behaviour, action and thought.

The problems arise not only with the assumption that a particular knowledge exists, and is in use, but also in the manner in which it is assessed or tapped. Bouffard (1986) concluded that much more precision is needed in measurement techniques if we are to establish clear relationships between presence and use of metacognitive knowledge. Findlay (1986) and Koutsouki-Koskina (1986) made the assumption that increased declarative knowledge would aid in the performance of *simple* aiming and tracking tasks, although the nature of the tasks themselves and the assessment of rule or image use was quite difficult.

Cautions concerning representation and assessment of the declarative knowledge base are also provided by Newell and Barclay (1982, p. 201).

> It should be recognized that knowledge about a process pertinent to the production of a response may not develop at the same rate or point in time as the use of that process by the child in the skills situation.

This variability in rate of development can also be extended to account for normal intrapersonal differences in domain specific knowledge and skills and in the range of performance displayed from handicapped to expert. In addition, much of our every day motor activity seems to defy accounts of its constructions, and therefore, a tacit level of knowledge representation for skilled action may be quite reasonable (Polanyi, 1958). The distinction between tacit and explicit knowledge and more specifically the role that cognition plays in our models of action must be carefully analyzed. We may be, through our initial biases and subsequent experimental techniques, developing a theory on the basis of what a system can do rather than on what it does do (Newell & Barclay, p. 206).

Implicit Theories Research

Consideration of the preceding problems inherent in knowledge-based research prompted the writer to seek a different mode of inquiry in order to gain a better understanding of the role of declarative knowledge in the development of skilled action. Implicit theories are based, or at least tested, on people's conceptions of what a particular phenomenon is. The data of interest are people's communications of their beliefs. Implicit theories already exist in the minds of people. If these theories can be discovered, they may offer considerable help in our construction of explicit theories.

Sternberg et al. (1981) have developed an extensive methodology for questioning people about their theories of intelligence. One of the first steps in conducting implicit theory research is to create a master list of characteristic behaviours. If one believes, as Sternberg does, that the study of practical intelligence is as valuable as the study of expertise, then the data should be gathered from a range of subjects, including lay people and experts in the particular domain under consideration.

Implicit knowledge research does not replace explicit theoretical analysis. It is another way of tackling the same problem. Sternberg has conducted a series of nine experiments in an attempt to gain support for his triarchic theory of intelligence. By analyzing the content of people's beliefs of what intelligent behaviour and people are, he was able to impose a three-factor structure of verbal intelligence, problem solving ability, and practical intelligence on the data. The resemblance of these factors to his triarchic subtheories: metacomponents, ability to deal with novelty, and environmental or contextual adaptation, is remarkable.

The important aspect of this research, however, is not how closely one can match implicit theories to explicit theories, but what additional information and understanding can be gained by having people declare their own conceptions or beliefs. Adaptation of the implicit knowledge approach to research in the physical domain is not done lightly. Logical criticisms of this mode of inquiry include the usual complaints of validity of questionnaires; the use of verbal reports as data (Ericsson & Simon, 1980); the removal of subjects from the domain of investigation and the requirement that they place themselves in it psychologically. One cannot assume either, that the characteristics generated by the subjects questioned are indeed those which will be demonstrated in the physical domain.

From another perspective, however, all of these criticisms can be seen as advantages. Isolation of declarative knowledge in a traditional experimental setting is very difficult. Perhaps identification of some of the characteristics that people implicitly regard as exemplary of skilled behaviour will help to shed light on a common base of declarative knowledge which is implicit, but not elusive. As Sternberg and Wagner state:

> Much of the knowledge upon which competence in the real world settings depends is tacit, that is, not openly expressed or stated...we do not wish to imply that such knowledge is completely inaccessible to conscious awareness, unspeakable, or even un-teachable, but merely that it is usually not taught directly to us.(1986, P.54).

It may, in fact, be possible to determine that there is a base of implicit knowledge which is common to most performers, regardless of their particular domain of expertise, and that variations in this knowledge base result from the interaction of skill level, age, experience, and the specific requirements of the sport. This type of research may allow much more explicit categorization of groups for treatment purposes, so that analysis of performance differences can reflect the true complexity of the action systems being studied. As mentioned earlier, an obvious study paradigm is provided by comparison of the knowledge of novices and experts, however, no longer is it sufficient to simply detail a bigger or better declarative base when explaining performance differences.

Novice/Expert Knowledge Differences

Tacit Knowledge

Much more information has become available in the last 10 years concerning differences not only in the performance characteristics but also in the cognitive behaviour of expert and novice performers. Initially many of these knowledge differences were simply categorized as either procedural or declarative, but Chi, Feltovich and Glaser (1981) were one of the first groups to note that much of an expert's knowledge appears to be unspoken.

> The analysis of features suggests that experts perceive more in a problem statement than do novices. They have a great deal of tacit knowledge that can be used to make inferences and derivations from the situation described by the problem statement. (p.147)

Although they were referring to the ability of experts to categorize physics problems in a manner which helped to dictate a correct solution, this kind of conclusion has also been made about the knowledge of basketball, volleyball, softball, and field hockey players (Allard & Burnett, 1985; Starkes, 1987). Some evidence of this tacit knowledge is provided in the work of Chiesi, Spilich and Voss (1979) who concluded that people with high baseball knowledge could make recognition judgments with less information than low knowledge subjects. Another way of stating this would be that experts make inferences rather than solving problems in a literal way (Thomas, French, Thomas, & Gallagher, 1988). Chi and Rees (1983) have explained that this ability to make quick solutions from an incomplete stimulus array is a function of the knowledge acquisition procedure. As experts acquire information they map it onto existing schemas, then these schemas serve as cues to indicate when critical information is missing.

Two studies by Ornstein, Naus and Liberty (1975; I & II) emphasize that the influence of the knowledge base can become so automatic that it may effect recall even in the absence of a superior strategy. In a study designed to measure changes in recall and rehearsal strategies with increasing age in third, sixth and ninth graders it was found that recall of a taxonomically related word list increased with age for words presented in both random and blocked fashion. The initial experiment, which used a list of unrelated words, also indicated that the use of active rehearsal (clustering a set of words to be remembered) as opposed to passive rehearsal (repeating each word as it appeared) increased with age. This same conclusion appeared to be the case in experiment II, that is, the more active the rehearsal, the better the recall. However, closer examination showed that third graders used passive rehearsal for both conditions, but were able to recall more of the blocked word list. Further evidence of this knowledge base effect was provided in a similar study by Ornstein, Naus and Miller (1977), in which sixth graders were instructed to rehearse passively in both conditions, and yet their recall of blocked items was superior to that of randomly organized materials.

Perhaps Bjorklund and Zeman (1982) provide the most obvious evidence of automatic influence of the knowledge base in their study of first, third, and fifth graders' memory for classmates names and other taxonomically related words. The results showed typical developmental trends in both recall and clustering with taxonomic words, but little difference in recall with classmates names. In fact, even young children were able to use clustering as a recall strategy for names, but when these same children were given a metamemory questionnaire, there seemed to be little awareness of the groups and categories that actually existed in their recall protocols.

The subtlety of knowledge base effects is further illustrated in a study by Naus and Ornstein (1983) comparing rehearsal and recall of adult experts and novices in the game of soccer. They found that no differences existed between the groups on recall or rehearsal of common, related words but that the soccer experts recalled more soccer terms than the novices. Investigation of the rehearsal strategies provided the most interesting information, however. The only difference in rehearsal strategy between novices and experts was found in the number of items in each rehearsal set which belonged to the category of the currently presented word in the soccer list. The novices failed to include more than two items as the list continued, but the experts could rehearse as many as four with increasing serial position of the word. Naus and Ornstein concluded that the use of this clustering strategy was deliberate, but that the opportunity to use it was provided by the rich knowledge base of the experts. The integrated nature of the knowledge structure suggests that tacit effects would not only be feasible but probable in all three knowledge domains, procedural, declarative and affective.

Procedural Knowledge

Although it is assumed that explicit procedural knowledge differences exist between novices and experts in a given field, documentation of these differences through research has not always been forthcoming. Starkes and Deakin (1984) have shown, in fact, that some areas of processing involving speed and accuracy which we would expect to differ according to skill level, do not always favour the expert performer. In an extensive review of studies involving stereoacuity (depth perception) and reaction time, just two of the procedural skills in which we would assume expert ball players to excel, they showed that there were no clear results favouring experts, and in many cases the methodological problems of many studies made adopting definitive conclusions impossible.

Starkes (1987) was able to illustrate this phenomenon further in a study of the national women's field hockey team in which she purposely compared their procedural and declarative skills to those of varsity and novice players. No differences were found in dynamic visual acuity, (measured by the ability to detect the position of a beam of light in the visual field), or coincident anticipation time (measured by the ability to predict reaction and movement time so that releasing a button would match the speed of a moving light). Differences in simple reaction time (measured by removing a finger from a key at the appearance of a stimulus light) were actually in favour of the two control groups. The national team players had significantly slower reaction time than both other groups. It would appear according to Starkes, that once a certain level of speed and accuracy (procedural knowledge) is achieved, differences in performance must be attributed to other kinds of knowledge.

Although the above analysis is tempting, Naus and Ornstein (1983) caution that investigations of the knowledge base must be conducted across a broad continuum of tasks which incorporate simplicity, complexity and automaticity. Studies need to be of a longitudinal and developmental nature so that systematic exposure to new bodies of knowledge can eliminate the confounding which now exists. They suggest that equivocal results should not be used as proof that the procedural knowledge base of experts and novices cannot be used as a point of comparison. It is the type of comparison that is important. Rather than specifying a dichotic contrast between experts and novices, a detailed description of the interrelationship among various changing components of the knowledge base needs to be given. This kind of argument would lead us to believe that the procedural differences which we intuitively perceive between national and novice level field hockey players exist at a level which is not tapped by a simple reaction time test.

Chi, Feltovich and Glaser (1981) conclude that clear differences are evident at the level of the schema. "Experts' schemata contain a great deal of procedural knowledge, with explicit conditions for applicability. Novices' schemata...contain elaborate declarative knowledge...but lack abstracted solution methods (p.151)." The interactive processing that is a feature of the human knowledge system not only accommodates but necessitates both a bottom-up or procedural analysis of problem solutions, and also a top-down or declarative analysis of problem configurations. The ability of the performer to match the problem and the solution will undoubtedly help to dictate the level of expertise which can develop at that moment. Since documentation of the structure of procedural knowledge at the level of schema analysis is still based largely on theoretical discussion, however, it is necessary to piece together the procedural knowledge puzzle with some care.

Even though there may be some question as to the procedural requirement of the tracking task investigated by Koutsouki-Koskina (1986) with grade 3 and grade 5 girls, clear differences were found between the accuracy level of the novice and more skilled trackers. Since these differences prevailed even for grade 3 experts over grade 5 novices, it is clear that they cannot be completely attributed to a function of development. The skilled trackers performed with a noticeable consistency between trials, whereas the novices at both ages were conspicuous by their inconsistency. Although Allard and Burnett (1985) feel that motor pattern consistency is not an issue in the performance of open skills, it is this very consistency which allows successful adaptation in an ever changing sport environment (Glencross, 1980; Tyldesley, 1980; Whiting, 1980).

In a similar study Causgrove and Watkinson (1989) were able to demonstrate that grade 5 physically awkward and grade 3 novice trackers exhibited a significantly high degree of error and variability in their performances compared to skilled trackers in grade 3 and grade 5. Since the constraints of the task limited the amount of learning that could occur over trials for all groups, the procedural element may have been confined to the automatic variety described by Naus and Ornstein (1983). Despite the laboratory nature of tracking a computer stimulus, there is still clear evidence of procedural superiority of both a developmental and knowledge based kind.

Although procedural knowledge research in the sports domain is limited at present, two studies conducted in ice hockey have used interesting measurement devices to analyze knowledge differences between skilled and unskilled performers. Marchiori, Wall, and Bedingfield (1987) did a comparative study of the accuracy and consistency of the hockey slap shot performed by two control subjects and two physically awkward boys. Measurements were conducted in the laboratory at baseline and at 2-week intervals during the completion of 1200 practice trials by the physically awkward children over a 6-week period. All performances were evaluated for angular velocity of the hockey stick and resultant puck velocity. The results indicated that the control subjects performed quite consistently with respect to stick velocity patterns and peak stick velocity, whereas the physically awkward children exhibited low stick velocity, poor timing and extremely inconsistent motor patterns even after 1200 practice trials. It seems evident from this study that poorly timed and executed motor patterns have a major effect on the ability to improve procedural skill.

Bard and Fleury (1981) conducted their hockey study with expert and non-expert goalies. The assumption was made that measuring visual search by the number of ocular fixations would give an indication of amount of time needed to register relevant contextual cues, the strategies used in the search process and also the surface area considered important to make an accurate decision. The subjects were required to react to oncoming sweep and slap shots in both laboratory and on-ice conditions. Dependent variables were mean reaction time (when the block was initiated) and fixation time on puck and stick. The results indicated that expert goalies not only initiated the block faster than novices no matter what type of shot was used, but could also decrease their reaction time considerably in conditions of greater uncertainty. Both novices and experts fixated the stick and the puck, but experts spent twice as much time viewing the stick in the slap shot as novices did. This study is particularly interesting because it shows that increased procedural knowledge may relate to specific differences in strategy use. Also the attempt to replicate game-like situations in this study goes a long way toward demonstrating those knowledge differences that are actually relevant in the sport domain.

Perhaps the best attempt to illustrate novice-expert procedural knowledge differences in a sport domain is the developmental study of basketball players conducted by French and Thomas (1987). They compared 8 to 10-year-old and 11 to 12-year-old novices and experts on actual measures of basketball knowledge, dribbling skill and shooting skill, and rated measures of performance in a game including control of the basketball, cognitive decisions, and motor execution. In the first experiment child experts exceeded novices in every area of measurement. In addition, basketball knowledge was significantly correlated with ability to make successful decisions within the context of the game, whereas successful execution of skills during a game was related to dribbling and shooting skill.

In a second experiment, the authors compared scores on the same measures for the 8 to 10-year sample of experts and novices at the beginning and end of the season. Both groups were able to improve their scores on the basketball knowledge test, the quality of their decisions and their control over the ball during a game. Neither group could advance their dribbling and shooting skills nor their motor skill execution during game play. These studies are important not only because they document knowledge base differences both within and without of the game context, but also because in using a multiple measurement approach they have also been able to document different rates of development for procedural and declarative knowledge in both experts and novices. Because these differences are evident in both game and drill situations, the need for both types of measurement in future studies seems even more evident.

Declarative Knowledge

Since de Groot's first study of chess in 1965 there have been many studies in the memory literature which document that experts in a particular domain possess a different kind of declarative knowledge than their less skilled peers. Initially, much of the work revolved around problem solving games like chess (Chase & Simon, 1973), Go (Reitman, 1976), and bridge (Charness, 1979), in which superior ability to recall or reproduce board or card patterns from memory was illustrated. Once it could be shown that experts had greater and more accurate recall of game structured information there was an attempt to manipulate the variables in order to determine more specific details about the development and structure of this knowledge base.

A landmark study in this regard was done by Chi (1978) when she compared adult-novice and 10-year-old-expert chess players on measures of immediate and repeated recall for chess positions. The child experts had significantly better recall, took fewer trials to learn chess positions, and recalled more and larger sized chunks of information than the adult novices. However, the children were not superior in memory for digits nor in the number of trials to learn a list of 10 digits. It was obvious that the chess knowledge itself had a profound effect on the performance of the children. This led Chi to conclude that developmental differences were more a product of a sophisticated knowledge base than superior memory strategies.

Knowledge organization was investigated further in the study of a four and a half year old boy and his recall for two lists of dinosaur names, one well known, the other less familiar (Chi, & Koeske, 1983). A semantic map of the two lists was constructed from the recall protocol of the child in order to determine dinosaur-dinosaur links. By playing a game of clue it was possible to construct dinosaur-property links. A third hierarchical group structure was imposed on the lists from categories suggested in the child's dinosaur books. The boy was retested for recognition of pictures of the same dinosaurs one year later. The researchers then were able to analyze his responses, not just for level of recall and recognition, which of course was greater for the known list, but also for organizational structure according to the semantic map. Results indicated that the better known dinosaur concepts yielded a greater total number of interdinosaur links, greater strength of linkages, and stronger within-group linkages. These characteristics, density, strength and cohesiveness were considered relatively stable signs of knowledge structure.

The powerful influence of knowledge structure on memory performance was shown in a two-part study by Lindberg (1980) in which he compared the recall of young children and college students for different types of information. In the first experiment subjects were instructed to perform one of four interference tasks after hearing each word in a list. The four conditions were: physical - tell whether a man or woman said the word; acoustic-generate a rhyme for the word; semantic-tell the meaning of the word: imagery-generate an image to the word. They were then required to recall the word list 20 seconds after the last word presentation. Large developmental differences were documented in the semantic and imagery conditions, but little or no differences in recall were noted in the acoustic and physical conditions. That is, adults' recall is no better than that of children when they have restricted knowledge of the stimuli.

Experiment 2 was even more interesting. It was hypothesized that if a strong knowledge base could account for developmental changes in memory then age-related increments in recall and clustering could be reversed if the stimulus items were more meaningful to the children than the adults. When third graders and college students were tested for recall of two word lists, one of items familiar to third graders and one of items within their vocabulary but more familiar to college students, a complete reversal of results was demonstrated. That is, when children were able to use a knowledge base that was richer for them than for adults, they were superior to the adults in both recall and clustering.

Although the first investigations of declarative knowledge were based on work in the field of academic problem solving, recent studies have pointed out that athletes have developed the same advanced forms of declarative knowledge as physics experts (Chi, Feltovich, & Glaser, 1981). Although the manifestation of this knowledge is specific to each sport domain, there is some consensus that experts perceive game information differently than novices. This expertise may involve more accurate recall of structured game situations in basketball (Allard, Graham, & Paarsalu, 1980) or field hockey (Starkes & Deakin, 1984), for example; or faster detection of ball presence in volleyball (Allard & Starkes, 1980) or location of impact in tennis (Jones & Miles, 1978). Illustrations of this superior knowledge base may ensue in simulated sport environments as in the above studies, or in isolated tests of verbal knowledge related to a particular sport such as baseball (Chiesi, Spilich, & Voss, 1979) and soccer (Naus & Ornstein, 1983).

In addition to the documentation of the effect of high knowledge on retrieval accuracy, there is also evidence that sport experts need less information from the environment in order to make decisions (Jones & Miles, 1978; Salmela & Fiorito, 1979; Bard & Fleury, 1981) but are not always more accurate (Chiesi, Spilich, & Voss, 1979) or more rapid (Starkes, 1987). It is perhaps in the area of complex decision accuracy however, that the benefit of a superior declarative knowledge base becomes most obvious. Thiffault showed in ice hockey (cited in Allard & Burnett, 1985) and Starkes illustrated in field hockey (1987), that experts make much better choices as to what is the most appropriate course of action in a forced-choice problem situation.

A final but no less important comment should be made about level of analysis. Chi, Feltovich and Glaser (1981) have indicated that experts analyse physics problems according to the underlying principles of physics, whereas novices seem to be limited by a literal interpretation of the cues in the problem statement. Murphy and Wright (1983) have similarly illustrated that expert diagnosticians seem to relate to a deep structure rather than a surface level analysis of psychological disturbances. The best parallel that can be drawn in the motor domain comes from a sorting task given to 11 expert and 10 non-basketball players in which they categorized 30 pictures of game situations according to whatever rules seemed sensible to them (Allard & Burnett, 1985). A hierarchical cluster analysis conducted on the two data sets determined two very different category structures. The novices categorized the situations into those depicting individual skills (few players) and those depicting team play (many players). The experts' sorts yielded 6 distinct groupings all related to the significance of the skills depicted, for example, team pressure defense or zone defense, and thus illustrated that their knowledge was organized according to the goal structure of the game rather than the surface structure of the skills.

Metacognitive Knowledge

This higher level of knowledge organization takes on a metacognitive flavour when players are required to predict the course of play in order to successfully score or prevent opponents from doing so. Although it has long been recognized that accurate prediction is a necessary quality of expert performers (Poulton, 1957), demonstrating this characteristic in a sport context has not been easy. Some examples of the ability to predict the flight of an object before impact are available in lawn tennis (Jones, 1978), table tennis (Bouffard, 1986), and ice hockey (Bard, Fleury, & Carriere, 1975; Salmela & Fiorito, 1979). Initiation of a blocking action in hockey as a response to prediction has also been shown by Bard and Fleury (1981), but other studies in basketball (Bard & Fleury, 1981) and field hockey (Starkes, 1987) which have attempted to demonstrate accurate choice of action have usually just involved decision making rather than execution.

One study which has attempted to monitor the decision making process in the actual game situation of basketball was conducted by French and Thomas (1987). Rather than measuring decision making as a timed response as is frequently the case in laboratory settings, expert and novice basketball players were actually monitored for the quality of their decision making during the game situation. The study was also able to show from pre and post measurements that a growth in metacognitive skill had occurred over the course of the basketball season with both novices and experts. This was an interesting finding since procedural knowledge did not improve in either group.

One aspect of metacognitive knowledge which has been highly emphasized in the literature is planning (Brown, 1978; Brown & DeLoache, 1978; Wall et al., 1985). Although strategic awareness is definitely evident in the number of goal-related solutions high knowledge baseball players could render (Chiesi, Spilich & Voss, 1979), or in the clusters generated by expert basketball players for game related situations (Allard & Burnett, 1985), planning per se has been addressed in a deliberate manner in very few studies to date.

A recent study by McPherson (1987) suggests that advanced child tennis players are more likely than novice child tennis players to plan game strategies between points and to verbalize these strategies ahead of time. Much more work needs to be done in this area in order to document an aspect of expert behaviour which cannot be denied.

Indeed, in all aspects of knowledge based research it is evident that careful definition of task conditions, performer characteristics, measurement techniques and knowledge parameters must be provided if a useful body of research is going to develop. Although some researchers have criticized attempts to explain skilled behaviour as too descriptive (Olson, 1986), Whiting suggests that the beginning of understanding lies in a precise description of the essential features of skilled performance (1980). In an attempt to provide some insight into the declarative knowledge domain at the implicit level, a useful point of comparison may be provided therefore by documenting skilled behaviour as the experts or theorists have tried to describe it.

Perceptions of Skill - The Experts Attempt a Description

There are probably as many different theories on the development of skilled behaviour as there are researchers in the domain. Although the details may have changed over the years much of what persists stems directly from the work of Fitts (1964). He described the three stages of skill learning as cognitive, associative, and autonomous. In the cognitive stage of development the learner is able to encode enough information to allow a crude approximation of the skill to be performed. In the associative stage the performer is able to detect errors and smooth out the movement pattern, whereas in the third, or autonomous stage continued gradual improvement in the execution of the skill is possible without conscious control.

It is interesting that Anderson (1982) adopted this basic three-stage theory of motor skill acquisition as the basis of his explanation of cognitive skill development. In Anderson's theory the stages become declarative,- the process of encoding instructions and facts about the skill in order to generate an initial attempt, what he called a propositional network; knowledge compilation- the process in which knowledge is converted to a procedural form; and procedural,- a stage involving fine tuning, increased speed of production and application of more efficient solutions to the skill problem. Anderson devised an intricate computer simulation to illustrate his ACT production system and the motor skill theorists have in turn benefitted from his insight, particularly with respect to the embedding of declarative knowledge in the procedures for performing a skill.

Though much of the Wall et al. (1985) model is in direct agreement with Anderson's hierarchical control theory, a major departure can be seen in the introduction of heterarchical control to facilitate understanding of the development of automaticity. Further differences can be seen in the addition of both affective and metacognitive knowledge bases to the declarative and procedural elements of Anderson's work. The affective component embraces the confidence which emerges with each successful execution of a skill, whereas the metacognitive component involves the ability to apply a synthesis of past knowledge to new problems with a high measure of success. It is apparent that development of metacognitive knowledge rests firmly on the availability of a solid declarative, procedural and affective foundation and therefore would logically develop at a later stage than the other three knowledge bases. However, the Wall model stresses the interactive nature of the development of procedural, declarative and affective knowledge during skill acquisition and as such would deny the stage theory of skill acquisition presented by Anderson.

Whiting offers an interesting solution to this dilemma of hierarchical control and individual differences with the concept of nested hierarchies.(1980). That is, development of skilled action in young children is under the control of one dominant hierarchy. However, as ontological development ensues, a broader dimension of control comes into operation so that any hierarchy can become dominant because of its appropriateness for matching the intention of the actor at a particular time. Perhaps Whiting provides us with the most sensitive framework for study when he says that the acquisition of motor skill reflects a state of *becoming*. The wisdom of this comment can be seen in the following analysis.

> When for example can it be said that a person has learned to dance? When he has mastered say, the basic steps in the waltz? When he has learned the waltz, quickstep, foxtrot and tango? Or, when he can respond in an appropriate manner in any situation which demands dance action? Perhaps, the answer is all of these depending upon the level of analysis to be specified (1980, p. 542).

Despite the obvious similarities in the four approaches to skill acquisition presented above, one cannot escape the differences which exist at the explanatory level. Although each theorist would undoubtedly argue for the inclusion or exclusion of a particular component in their version of what develops, there still seems to be a common understanding of what is encompassed in skilled behaviour at the descriptive level. Pylyshyn (1978) would argue that attribution of beliefs is not justified unless one can both articulate as well as demonstrate a relationship, that is, give evidence of declarative and procedural knowledge. For many however, seeing is believing.

One of the first characteristics which is mentioned in descriptions of skilled behaviour is speed. Skilled performers seem to be able to perform the correct action at a much more rapid rate than their less skilled peers. Speed may not be required in all sports, or in all aspects of a skill domain, and in some contexts, faster is not necessarily better, but in most cases faster decision making is a definite advantage. Whether the performer's skill is evident in quick action or quick thinking or in a combination of both, the resulting benefit is usually quite easily observed (Thomas, French, Thomas & Gallagher, 1988; Allard & Starkes, 1980).

Accuracy is a second quality that is expected in skilled behaviour. Like speed, accuracy can refer not only to the precision with which an action is executed but also its appropriateness in solving the task at hand. Another word which often accompanies the concept of accuracy is efficiency. There is a noticeable ease with which the actor performs. Skilled behaviour is expected to be parsimonious (Campione, Brown, Ferrara, 1982; Wall et al., 1985; Starkes, 1987). Perhaps Gardner states it best when he says:

> It is just because of this mastery of the possible alternatives, the ability to enact the sequence most effective for present purposes, that the expert looks as though he has all the time in the world to do what he wants (p. 209).

Skilled behaviour is also associated with the ability to produce a consistent motor pattern. Consistency is important to the performer because it makes for a reliability that is conducive to coordinated and controlled action. Consistency allows the actor to join patterns together to produce more complex acts and to develop increasing levels of automaticity so that the performer need attend only to the most difficult or challenging aspect of a task (Keogh, 1977; Newell, 1985; Allard & Burnett, 1985).

When a performer has developed consistency, accuracy and speed, there is an increased level of flexibility which makes adapting to new task demands or changes in the environment possible. A skilled performer then is not just someone who can perform a prescribed task, but someone who can solve a new action problem with a high degree of success (Glencross, 1980:, Newell & Barclay, 1982; Fisher, 1984;). Many theorists have concluded that this adaptability is directly related to the ability to infer a solution from a limited amount of information in the environment (Anderson, 1982; Markman, 1981) or draw conclusions directly related to game structures rather than surface conditions (Chi, Feltovich & Glaser, 1981; Allard & Burnett, 1985; Starkes & Deakin, 1984).

Continued experiences of success foster a high level of confidence in the skilled (Mahoney & Avener, 1977; Highlen & Bennett, 1979; Griffin & Keogh, 1982). Confidence may be seen in the directness of their approach, but also in the fact that they seem to have an implicit understanding of what is going on. This extra sense has been called acquaintance knowledge by Whiting (1980), tacit knowledge by Polanyi (1958), and Newell and Barclay (1982), and implicit knowledge by Sternberg (1986). Just as the other characteristics of skilled behaviour take long hours of practice to develop, it is felt that implicit knowledge comes about as a result of many hours of successful experience (Thomas, French, Thomas & Gallagher, 1988). Although it seems difficult for researchers to characterize this extra knowledge base, there is some consensus that it exists.

What is Domain Specificity?

All of the descriptive characteristics of skilled behaviour listed above apply in some measure and combination to performers in different skill domains. In fact, if we apply Gardner's (1983) theories of multiple intelligences, bodily kinaesthetic intelligence would entail the ability "to use one's body in highly differentiated and skilled ways, for expressive as well as goal-directed purposes" (1983, p. 206). Perhaps dance best typifies the most widely used form of bodily movement for the purpose of expression in all cultures. As in all forms of skilled behaviour dancers spend many hours perfecting their skill. It is characterized by patterned sequences of bodily movements that reflect a purpose, an intentional rhythmicity, and an aesthetic quality in the eyes of the observer (Hanna, 1979). Although, as Whiting so aptly noted, there are a great variety of forms and levels on which dance can be analyzed, certain features do appear common in many dance contexts.

Dancers are particularly concerned with precise execution of dance movements in shape and time. As dance is a skill frequently performed for both the dancer's and the viewer's enjoyment, there is attention to placement, stage spacing and attainment of a quality of movement which will adequately convey the ideas and emotions designed by the choreographer. The dancer must often combine different qualities of speed, direction, distance, intensity, and force in very subtle ways (Gardner, 1983). Although one might at particular times wish to leap as high as possible, in comparison to a high jumper's skill domain, this level of intensity would not always be the objective in all or indeed any part of a dance sequence. As Foster would say, "you need to jump as a dancer, not as an athlete" (1976, p. 43).

Rhythmicity should be emphasized if only because dance is frequently accompanied by some form of music or audible beat. The dancer is charged with the task of meshing the two rhythms of movement and music to create the desired effect. Sometimes the music will dictate the movement, sometimes the movement will seem to foreshadow the music, but the skilled dancer is able to marry the two so that the composite has a unity.

In order to be able to develop this unity the dancer works to create a large vocabulary of dance moves. It has been said that dancers have difficulty in verbally articulating the elements of their craft as is evident in Martha Graham's famous statement,"If I could tell you what it is, I would not have danced it " (1973). There appears to be some agreement however, that the ability to verbalize dance elements affords a clarity, a common descriptive language and a basis for depicting shades of meaning according to a particular dance context (Gates, 1968; Gardner, 1983). Perhaps dancers have such a highly developed ability to watch, to observe carefully, to imitate and to recreate, that the use of verbal descriptors often seems redundant. Martin describes this capacity to act gracefully and to capture the actions of other people or objects as a sixth sense of kinesthesis (1965).

It is interesting that graceful action is also mentioned as a characteristic of skilled athletes, but in the athlete's case it is remarkable because of the pressure of uncertainty and the time constraints which are always part of a competitive sport situation (Gardner, 1983). Therefore, rather than monitoring the movements of others and faithfully recreating them, the athlete may attend to the actions of an opponent so that effective counteractive strategies can be planned (Allard & Burnett, 1985).

Strategic planning often requires the athlete to anticipate the actions of others in both defensive and offensive roles. This anticipation requires rapid recognition and recall of individual skill sequences and game patterns (Thomas, French, Thomas & Gallagher, 1988; Allard & Burnett, 1985). In many sports this activity must be coordinated with other team members so that each person is contributing to the same end in his own way. The skilled athlete develops a particular sense of timing in relationship to both his own sequence of actions and the integration of performances from each player on the team (Gardner, 1983).

Since it takes many hours of practice to develop specific sport skills to such a high level, there appears to be an accompanying high level of motivation and enjoyment which helps sustain the athlete through many difficult situations. This enjoyment can be characterized as both a personal pride in achievement and a joy of performing with and for others. As Foster puts it, "they usually know during the process of running, jumping or throwing when the action feels absolutely right and this, as well as the signal of success brings a tremendous sense of exhilaration" (1976, p. 8).

It is interesting to note that athletes just like dancers may have some difficulty describing their skill in words. Lowe typifies this problem in his statement, "there is control...craft...poise...and...'stuff'" (1977, p.308). And yet many theorists consider the ability to declare one's skill an important element of truly skillful behaviour (Anderson, 1982; Brown, 1978; Starkes, 1987; Wall et al., 1985). There are many ways in which language can be used to measure one's knowledge of skill. Perhaps the ability to state a goal in words, convey instructions verbally, criticize one's own performance, or coach another individual is a type of symbolic competence not equally developed in skilled performers.

Characteristics of the Unskilled

Just as examination of novice and expert behaviour can be helpful in revealing what constitute the characteristics of skilled behaviour, careful attention to the difficulties experienced by the unskilled may provide equally valuable knowledge to the researcher. In fact, Gardner (1983) has done just that. He has used the information gathered from studies on brain damage, specifically apraxia, to help support his theory of bodily-kinaesthetic intelligence. In Gardner's view the selective impairment that can result from damage to the left hemisphere provides good support for his theory that bodily intelligence is a realm quite separate from linguistic and logical forms of intellect. Apraxics often have difficulty carrying out a set of motor sequences in the right order or correct manner even though they understand the request and are physically capable of performing the tasks. It is interesting to note that the type of poor execution and omission of action that typifies some apraxics is also seen in normal people when they are performing under stressful conditions.

A much more detailed body of work on the causes and outcomes of apraxia is provided by Roy (1985). Roy defines apraxia as a disorder of limb function which is not due to deficits in basic motor function, lack of comprehension of the action, or sensory loss (Roy, 1983a). Although Geschwind (1975) has tended to explain this disorder as a problem of executive control, more recent work leans toward a coalitional style of control based on heterarchical organization of the motor system (Kelso & Tuller, 1981). Roy suggests that coordination of action depends on the operation of two systems. The conceptual system incorporates three elements: functional knowledge of tools, functional knowledge of action, and understanding of sequential action characteristics. This system is bound by internal linguistic and perceptual referents which provide the source for top-down or executive control of behaviour. The production system, on the other hand, which is involved with generating the action, tends to be environmentally driven and thus provides the bottom-up aspect of control. In investigations of left hemisphere patients with perseverative errors Roy was able to determine that perseveration seemed to relate to difficulties in the production system whereas sequencing errors tended to relate to problems in the conceptual system and in particular to lack of attention at key transition points in the action (1985). Although Roy's work does not deny the existence of bodily-kinaesthetic intelligence as Gardner envisages it, his work with adult apraxics certainly emphasizes the complexity of the human action system.

In contrast, work with unskilled children has tended to concentrate on difficulties which seem to arise out of no known etiology. The term developmental dyspraxia has been used to denote impairment in children which usually involves poor performance in learning new skills and non-habitual tasks although initial development may have appeared quite normal (Cermak, 1985). Ayres (1972) believes dyspraxia results from a problem of sensory integration related to deficiencies in the tactile system. Because children are unable to accurately interpret spatial and temporal information provided through the sense of touch they have particular difficulties in the planning stage of movement. In some accounts there is evidence of accompanying language deficits (Garvey, 1980), and in others good language skills have been reported (Gubbay, 1975). Most recent work with unskilled children tends to focus on the existence of learning difficulties in other domains, particularly reading disorders (McKinlay, 1980; Taylor, 1984). As attempts to categorize clinical samples have been largely unsuccessful because of no single pattern of deficits, it appears that irregularities in the developing action system may be just as complex as those which have been documented in the adult system.

One attempt to integrate many of the above ideas under a general developmental model of motor skill acquisition is provided by Wall et al. (1985). The knowledge-based approach to the problem of developmental clumsiness or awkwardness defines declarative and procedural systems which are quite comparable to Roy's two-system model, but which allow for important elements of motivation and attention to be subsumed in the affective and metacognitive domains of the knowledge base. Although the specific mechanisms for control might differ in some details there is congruence with Roy with respect to distribution of control. The Wall model tends to emphasize the importance of affective knowledge in children who demonstrate awkwardness, although research documenting low self esteem is limited (Griffin & Keogh, 1982; Taylor, 1985). In addition it is inferred that if any one of the knowledge bases is severely impaired, the chance of developing active metacognitive skills is considerably reduced. Despite the differing levels of analysis which are clearly evident in the above approaches to unskilled behaviour, there are still a number of descriptors which tend to recur in many theoretical and observational accounts of the problem.

It would be simple to say that the unskilled can be characterized by a lack of those characteristics which have been used to describe skilled behaviour. That is, their actions are slow, inaccurate, inconsistent, uncontrolled, and they lack the confidence and ability to adapt to new situations or understand the subtleties of action situations related to games play. Although it is true that most of these comments have been raised when referring to those who lack skilled behaviour, there is a body of knowledge which tends to isolate particular problems related to performance inadequacy with some frequency.

One of the most commonly mentioned characteristics describing the unskilled is the inability to perform complex movement tasks (Roy, 1983b; Taylor, 1982; Cermak, 1985). Complexity frequently entails the integration of simpler movements into a sequential whole which must be executed in a quick and effortless fashion. Errors in sequencing which occur due to omission or inaccurate ordering often occur in the developmental stages of skill learning, but when these problems persist successful execution of complex actions may continually elude the performer (Gardner, 1983; Roy, 1983a).

This situation is frequently made more difficult if the performer cannot effectively plan a course of action (Roy, 1978; Conrad, Cermak & Drake, 1988). Inability to plan skilled action sequences to achieve the desired end may be a function of the short time frame in which the plan must be formulated (Roy, 1983a), and the general disorganization which characterizes the skill repertoire (Bradley, 1980; Cermak, 1985). Since the movement patterns often lack accuracy and consistency, it is easy to see how planning complex actions would often be little more than guess work at the best of times (Marchiori, Wall, & Bedingfield, 1987; Causgrove & Watkinson, 1989).

Perhaps an even more serious consequence of unskilled behaviour is the inability to move or manipulate objects satisfactorily in simple, everyday living skills (Morris & Whiting, 1971; Taylor, 1984; Hulme & Lord, 1986). Children may exhibit these difficulties in the basic patterns of walking and running and also in the finer movements needed for dressing and eating. In most people these skills become quickly automatized so that they can be performed with little effort or attention. Awkward children often find themselves in the situation where they must plan even very simple movements if they want a successful outcome (Cermak, 1985).

It is not surprising therefore that low self esteem is frequently mentioned as a characteristic of the unskilled (Wall & Taylor, 1984; Taylor, 1984; Wall et al., 1985; Cermak, 1985). Even though the knowledge which is necessary to perform adequately is often unattainable, the physically awkward seem to be painfully aware of their performance inadequacies. They lack the enjoyment which is characteristic of the skilled, and they tend to withdraw from active sport and choose more sedentary activities (Cermak, 1985; Gubbay, 1975). Reid (1986) suggests that the passivity which we witness may be due to a lack of appropriate strategies, many of which have not been identified or may be of a tacit nature.

Whether it is lack of strategies or lack of motivation or some combination of the two, feelings of inadequacy serve to discourage the awkward performer from practicing motor skills to any appreciable degree (Gordon & McKinlay, 1980; Wall & Taylor, 1984). Consequently the quality and proficiency with which they execute many motor skills is limited. In addition, they seem to lack the physical fitness which would allow them to practice for any extended period of time (Paton, 1986). Although it is questionable whether unsupervised practice serves any useful purpose for awkward performers, it is clear that practice is of considerable benefit to producing skilled performers (Marchiori, Wall, & Bedingfield, 1987).

In summary then, it is evident that there is no shortage of either explanatory or descriptive accounts of the nature of skilled behaviour. Attempts to illustrate these beliefs in experimental studies have not always met with success. Researchers have often unearthed as many questions as they have answered in each new investigation. The complexity of skilled behaviour itself dictates that no one study can provide the perfect solution to these questions. The introduction of the knowledge-based model (Wall et al., 1985) was an attempt to furnish a general understanding of what develops during skill acquisition so that more fruitful inquiries could be made. Results of the several studies which have applied this model in studying the nature of skill with child novices and experts, the mentally handicapped and the physically awkward suggested that another look at the model was warranted. It was the goal of the present study, therefore, to add to the understanding of skill as provided in the knowledge-based model by isolating and investigating the nature of declarative knowledge. Application of Sternberg's paradigm of implicit theoretical analysis (1981) provided an opportunity to revisit the nature of skill without arbitrarily imposing our explicit theoretical assumptions. A description of this inquiry into implicit theories is provided in the following chapter.

CHAPTER 3

METHOD

Pilot Study

Implicit Knowledge Research

According to Sternberg (1986) the first step in implicit theoretical analysis almost always involves the collection of listings of behaviours or traits that characterize people's conceptions of the domain of inquiry. In applying this rather new methodology to inquiry in the physical skills domain there was some speculation on whether people would in fact be able to generate a list of descriptors which they felt characterized skilled behaviour. To test this rather phenomenological approach a pilot study was conducted on a sample of 40 library users selected from four reading rooms on the University of Alberta campus by questioning every third person present.

Each person was greeted with the following statement and asked to respond to one question only:

"Hello, I am conducting research at the University of Alberta. Would you be able to spare 5 minutes to help me? Could you list as many behaviours as you can think of which are characteristic of a :

1) skilled athlete
2) skilled dancer
3) person who moves well
4) person who moves with difficulty."

Each person then received a rating sheet with the following instructions:

Please rate yourself from 1(low) to 9(high) on your:

1) athletic ability

2) dancing ability

3) ability to move well

The rating sheet was given to each subject after the list of behaviours had been composed. The order of questions on the rating scales was randomized to limit bias due to this factor. Each subject was told that the study was designed to ascertain personal ideas about skill, that there was no right answer and to list as many behaviours as possible.

Results of the pilot were informative and encouraging. In general, respondents were able to generate a list of behaviours quite easily. They cooperated and only two people refused because of time restrictions to take part in the study.

Table 2 summarizes the most frequently generated behaviours for each question. Although not evident from this table, somewhat fewer behaviours were generated for the Moves Well question. It was decided that the addition of the word observable would help respondents to visualize the action that they were reporting on. In addition, question 4, Moves with Difficulty, required a great deal of explanation and often created the impression of physical disability. Rick Hansen's visit to Edmonton was imminent and it appeared that sensitivity to movement problems for some people gave the image of injury and obvious impairment.

Table 2

Comparison of Most Frequently Generated Behaviours By Question

Athlete		Dancer		Moves Well		Moves With Difficulty	
cooperative	6	graceful	7	graceful	6	uncoordinated	7
confident	5	flexible	6	smooth	5	anxious	6
intense	4	expressive	5	aware	4	lacks balance	5
stable	4	rhythmic	5	confident	4	not confident	5
		poised	4	balance	4		
				coordinated	4		
				posture	4		

In order to find a question that would evoke the image of unskilled behaviour without impairment, five new questions were devised to tap the implicit knowledge domain. Subjects were selected from the libraries but from different reading rooms in an attempt to avoid overlap with the initial sample. The word observable was included in the question and subjects were asked to list as many observable behaviours as they could think of which were characteristic of a person who:

1) does not move well
2) lacks motor or physical skills
3) performs motor skills poorly
4) is unskilled at movement
5) is awkward in executing motor skills

Each question was evaluated according to the criteria previously established, that is, the questions must be quickly understood, require little explanation, evoke an immediate response, and not connote the impression of physical impairment. As the pilot work on this question ensued it became quite obvious after surveying 20 subjects that question 3 and 5 lacked clarity and did not evoke clear images for the respondents. Three more subjects were surveyed using the remaining 3 questions and question 4 "a person who is unskilled at movement" was finally chosen as the best question. It seldom required any explanation or request from the subjects as to what was meant.

The results of this pilot work were quite encouraging. Preliminary categorization of the data revealed that the library group were indeed able to generate what appeared on the surface to be a logical list of: "unskilled" behaviours. They were also able to rate themselves on the three abilities listed and could generate their knowledge relatively quickly (5-10 minutes). The researcher made the assumption therefore that implicit knowledge of physical skill was a phenomenon which could be tapped.

The Study

The study that evolved from this preliminary work attempted to mirror Sternberg's study reported in 1981. In his first experiment he questioned three groups including 61 people studying in a library at Yale, 63 waiting for commuter trains at New Haven station, and 62 people entering a super market. Sternberg's subjects were asked to list behaviours of intelligence, academic intelligence, everyday intelligence or unintelligence and then to rate their own intelligence, academic intelligence and everyday intelligence. From this initial study a master list of 250 behaviours was generated, 170 were for three kinds of intelligence and 80 were for unintelligence. Results of the first study indicated that people have organized conceptions of intelligent behaviour that differ only somewhat in the degree of importance they place on either academic or everyday intelligence.

In his second study Sternberg had experts and lay people rate the behaviours in the master list generated by the first study according to their importance and characteristicness in defining an ideally intelligent person. Results of the second study showed that experts and laypersons had similar but not identical prototypes of intelligent functioning. The prototypes evidenced practical problem solving ability, verbal ability and social competence. Sternberg also found that self-ratings of intelligence were highly predictive of intelligence and academic intelligence.

In adopting the Sternberg paradigm to study the phenomenon of movement intelligence some changes seemed advisable. Since there was evidence from more than one study that lay people and experts had similar views of the question under study, it was decided to include experts in the initial data gathering or generation of behaviour listings. Not only would the experts be able to contribute their ideas, but they would also compose the group with domain specific knowledge, an important consideration of this study. The first two steps of the study, collection of the behaviour listings and creation of the master list are described below.

Step 1: Collection of Behaviour Listings

Subjects

The subjects consisted of 243 people ranging in age from 11 to 60, the majority of subjects were in the 15-to 25-year age group. There were four groups:

a) library users on campus
b) first year physical education students -who had completed one compulsory dance course
c) novice jazz dancers , that is those with less than 5 years experience
d) expert dancers and teachers, those with more than 5 years experience

<u>Procedure</u>

Each subject answered one of the following questions:

Could you list as many observable behaviours as you can think of which are characteristic of a :

1) skilled athlete
2) skilled dancer
3) person who moves well
4) person who is unskilled at movement

Please rate yourself from l(low) to 9(high) on your:

1) athletic ability 1 2 3 4 5 6 7 8 9
2) dancing ability 1 2 3 4 5 6 7 8 9
3) ability to move well 1 2 3 4 5 6 7 8 9

Table 3

Sample Characteristics

Group Characteristics	Library 1	Phys. Ed. Major 2	Novice Dancer 3	Expert Dancer 4
Male	30	35	3	2
Female	30	28	57	58
Age Range	16-45	15-40	11-45	11-60
Median Age Range*	21-25	15-20	21-25	21-25
Yrs. Jazz Experience	NA	1 Course	2.03	9.98

*Ages were recorded by range, therefore a mean score was not computed.

<u>Attempts to Improve Validity</u>

The sample groups were quite different in make-up. Attempts were made, however, to keep the general data gathering procedure as similar as possible for each person. Each person received a paper with the question typed at the top. The question was read by the researcher and the subject was asked to list as many behaviours as possible. The questions were delivered in the order: athlete, dancer, moves well, unskilled. The rating sheet was given to the subject after the behavioural list had been composed.

The order of each question in the rating scales was randomized to limit bias due to this factor. All subjects were told that the study was designed to ascertain their ideas about skill, that there was no right answer, and to list as many behaviours as they could.

In the library sample, every third person in four different library reading rooms was sampled by the researcher on an individual basis. The data collected from the library group in the initial pilot study were included as part of this study. All students who had taken the Physical Education and Sport Studies introductory dance course and wished to complete the questionnaire were sampled in group 2. The question papers were distributed to each person in the group. As soon as behaviours had been generated, the student handed in the paper and was given a rating scale to complete. An attempt was made with the first two groups to sample an equal number of males and females. This procedure was not possible in the novice and expert groups as females far outnumbered males.

The novice dance group involved many jazz dancers who attended Dance Extravaganza '87, who were registered in the beginner classes and who had less than 5 years experience. The expert dancers involved many jazz dancers and teachers who attended Extravaganza '87, who were registered in advanced classes and had more than 5 years experience. Both of these samples were supplemented by dancers and teachers in studio and Jazz Moves classes in order to keep the sample sizes the same. In each case the data collection procedure was kept similar.

The purpose of Step 1 was to create a data base from which the answer to the first question could be formed. Is it possible to demonstrate implicit knowledge of the characteristics of skilled behaviour? The assumption was made following the ideas of Sternberg, Gardner, and Wall et al., that the characteristics of motor skill could be modeled in both a componential and a particularistic way; that just as there are multiple intelligences, there is domain specific knowledge in motor skill; and that if people indeed have declarative knowledge of skilled behaviour they should be able to verbalize this knowledge. Preparation of a master list was the first indication that this implicit knowledge could be demonstrated.

Step 2: Creation of the Master List

Data lists were typed from the characteristics prepared by each subject (See Appendix A). Each subject's list was identified by an identification number so that the group membership and sex of each subject was known only to the primary researcher. The characteristics were typed in the order given by the subject and only spelling errors were corrected. The number of distinct characteristics was also indicated by a slash if more than one behaviour was listed on the same line. The total data list was prepared by groups in a random fashion so that the groups and the particular question answered were not ordered in any systematic way. The question which each group of subjects answered was typed at the beginning of each group data set. Coders were instructed in the following way.

Instructions for Initial Coding of Data.

The objective of your task is to create two master lists of distinct behaviours which represent the concepts of skilled and unskilled motor behaviour. The master list of skilled behaviours will comprise the three components of athletic skill, dancing skill, and movement skill. You will receive four lists for each component. The master list of unskilled behaviours will comprise four lists defining the concept of unskilled at movement.

Procedure:

1. Identify each behaviour listed below as either distinct or the same as one previously listed.
2. Assign a number to each behaviour listed, starting with the number 1.
3. When the following behaviour is distinct from all previous ones, assign a new number. When the behaviour listed is the same as one previously listed assign the number given to the original behaviour.
4. Record a number for each behaviour in the space provided on the list.
5. Create a master list by recording each new number corresponding to a new behaviour on the duplicate data sheets.

Special Instructions to Help You

1. Identify all identical words and their root words as the same behaviours eg. rhythmic = rhythmical.
2. Separate all behaviours which are distinct from one another when they appear in the same phrase eg. drags feet, trips = 1. drags feet, 2. trips.
3. Behaviour lists for each subject are separated by their ID number. When obvious synonyms appear in one subject's list eg. 2= unsure (2=hesitant) count these as one behaviour by numbering the first behaviour and numbering the second behaviour with the same number and placing brackets around the synonym and the number.
4. Please do the numbering of behaviours in the order they have been presented to you. Adjust the timing to suit yourself. I think doing one set of athlete, dancer, moves well at a time would probably be good. Then take a break. When you resume, review your master list to refresh your memory so that you will be familiar with behaviours that have already been listed.
5. When in doubt whether two behaviours are identical it is better to keep them separate, as they can always be merged later (Sternberg, 1986).

In order to minimize bias in the creation of a master list three coders were given the complete list of characteristics describing skilled and unskilled behaviour. Their task was to identify each distinct behaviour by assigning it a consecutive number beginning with one, and to categorize all similar behaviours by assigning the same number to each, as indicated in the above instructions. Completion of the first task generated the initial master list, and categorization of all similar behaviours identified every characteristic as belonging to a particular behaviour category. The internal consistency of each coder was determined by computing the number of correct categorizations that were made.

A categorization was determined correct if it was indeed new, that is not before previously mentioned, if the number assigned previously was used for the same characteristic when it reappeared, and if the similarity could be generally supported. There were 1297 characteristics generated initially by the 182 subjects answering the questions relating to skilled behaviour. Following the methodology of Sternberg, even if a behaviour was only listed once it was included in the initial behavioural listing. Four of the 1297 behaviours were considered uncodable because the intent of the subject was unclear, therefore the internal consistency was calculated on 1293 behaviour characteristics. By applying the following formula it was possible to compute an internal consistency score for each rater. For example,

$$\frac{\text{number of agreements} \times 100}{\text{total number of behaviours}} = \text{percent consistency}$$

$$\frac{1149 \times 100}{1293} = 88.9\% \text{ consistency on the skilled data set}$$

and

$$\frac{322 \times 100}{388} = 82.9\% \text{ consistency on the unskilled data set}$$

The most consistent lists (88.9% for skilled behaviour and 83% for unskilled) were accepted. This initial analysis yielded a master list of 127 skilled and 92 unskilled behaviour characteristics from the 1293 (skilled) and 388 (unskilled) behaviours originally generated (See Appendix B for original behaviour lists). The errors identified in coding were then corrected. Most of the errors related to the lengthy list of data and memory failure, rather than conceptual difficulties or lack of understanding. Behaviour characteristics which had already been given a number were sometimes identified as new in the latter stages of the coding procedure, or a behaviour would be accidently given a wrong number, for example, 48 instead of 49, and this incorrect number would be used for the rest of the coding. The corrected master list was then given to a second rater to be used in categorizing the entire list of 1293 behaviours again. Agreement with the master list using the same formula as above was 81.3 percent.

Reduction of Data and Further Correction of Initial Master List

At this stage, behaviour category lists were prepared giving each behaviour coded for every category in the order they appeared in the data set. The list was read and reread so that corrections could be made for any behaviours which did not appear to fit in their category. Examples of behaviour lists before and after correction are provided below for both the skilled and unskilled data sets in the following tables.

Table 4

Behaviours in Category 12-Skilled: Before Correction

Behaviours
Detailed study of the nuances of his/her discipline
careful attention to detail
complete understanding of the game
show proper training for the activity; ie, development of particular muscles or stamina needed for the sport
the degree of knowledge he/she has about the game
knowledge about dance
knowledgeable on the skill they are good at
knowledge
knowledgeable
they know their sport well
understanding of all basic technique pertaining to specific form of dance
movements are executed to the fullest- a sense of completion of line, or height in jumps, fullness of action
uses each exercise to develop particular body parts
understands when to stretch, when to push
knows how to conserve energy
interest in his/her sport
knowledge of different dances
known dance steps (eg. pirouette)
being able to perform different variations of dance
one track mind - their sport

***Behaviours which were moved to other categories**

Table 5

Behaviours in Category 12-Skilled: After Correction

Behaviours
Knowledgeable
Detailed study of the nuances of his/her discipline
careful attention to detail
complete understanding of the game
show proper training for the activity; ie, development of particular muscles or stamina needed for the sport
the degree of knowledge he/she has about the game
knowledge about dance
knowledgeable on the skill they are good at
knowledge
knowledgeable
they know their sport well
understanding of all basic technique pertaining to specific form of dance
uses each exercise to develop particular body parts
understands when to stretch, when to push
knows how to conserve energy
interest in his/her sport
knowledge of different dances
known dance steps (eg. pirouette)
one track mind - their sport
educated
perhaps an ability to teach it
ballet technique and training for control

***Behaviours which were added from other categories.**

To correct and reduce the initial 127 category master list of skilled behaviours, 40 categories were dropped because they were mentioned only once and could not be collapsed into another like category; 15 categories were collapsed into other categories; and some behaviours which seemed to fit better in other categories were moved. This left a master list of 72 skilled behaviours which was then transposed to data sheets for computer analysis. Each subject had a 72 variable list and the presence of a variable was indicated by a 1, while the absence was indicated by a 0. When a subject chose a variable more than once the duplicate choices were disregarded. Following is an example of data reduction for the unskilled data set.

Table 6

Behaviours in Category 1-Unskilled: Before Correction

Behaviours
Hesitancy
nervous gestures, unconfident apologetic postures
hesitant
hesitant motion - taking steps in 3 different directions
brief pauses prior to beginning a movement, especially movements requiring a motor program for automaticity
person appears to be concentrating on how to perform the next step in the movement
hesitant
unsure in attitude
hesitant
hesitate
tentativeness
jerky movements
hesitant movements
unsureness
hesitant
they would probably not be secure on the way they moved

***Behaviours which were moved to other categories**

Table 7

Behaviours in Category 1-Unskilled: After Correction

Behaviours
Hesitancy
hesitant
hesitant motion - taking steps in 3 different directions
brief pauses prior to beginning a movement, especially movements requiring a motor program for automaticity
hesitant
hesitant
hesitate
tentativeness
hesitant movements
hesitation
tentative movements
unsureness
hesitant
they would probably not be secure on the way they moved
not confident in moving

*Behaviours which were moved to other categories.

To correct and reduce the initial 92 category master list of unskilled behaviours 6 categories were dropped because they were mentioned only once and could not be collapsed into another like category; 53 categories were collapsed into other categories; behaviours which seemed to fit better in other categories were moved. This left a master list of 33 unskilled behaviours which was then transposed to data sheets for computer analysis. Following are the two master lists which resulted from this data reduction process.

Table 8

Master List of Skilled Behaviours

1. Motivated	25. Dedicated	49. Stable
2. Fit	26. Outgoing	50. Artistic
3. Competitive	27. Sportsmanlike	51. Creative
4. Durable	28. Aggressive	52. Has Body Awareness
5. Trains Regularly	29. Has Humour	53. Dynamic
6. Mentally Alert	30. Mesomorph	54. Well Extended
7. Controls Stress	31. Participates	55. Expressive
8. Cooperative	32. Conforms	56. Happy
9. Deterministic	33. Graceful	57. Young
10. Egotistic	34. Focused	58. Musical
11. Well Practiced	35. Confident	59. Has Long Body
12. Knowledgeable	36. Naturally Skilled	60. Thoughtful
13. Receptive	37. Optimistic	61. Wears Gym Shoes
14. Lean	38. Ritualistic	62. Dresses Casually
15. Strong	39. Dramatic	63. Wants to Learn
16. Muscular	40. Proud	64. Unsatisfied
17. Perceptive	41. Abstract	65. Frequents Gym
18. Skilled	42. Peaceful	66. Reacts Quickly
19. Flexible	43. Rhythmical	67. Has Personality
20. Fast	44. Erect	68. Communicative
21. Coordinated	45. Pretty/Handsome	69. Adapts Skills
22. Agile	46. Petite	70. Loves Dance
23. Mature	47. Feminine	71. Respects Body
24. Immature	48. Eccentric	72. Has Presence

Table 9

Master List of Unskilled Behaviours

1. Hesitant	18. Intense
2. Inflexible	19. Frustrated
3. Awkward	20. Unmotivated
4. Uncoordinated	21. Lacks Automaticity
5. Requires Effort	22. Unskilled
6. Strong Movements	23. Has Poor Body Image
7. Lacks Balance	24. Imitates Others
8. Lacks Rhythm	25. Confused
9. Unsure	26. Lacks Practice
10. Lacks Control	27. Unable To Isolate
11. Has Poor Gait	28. Deviant
12. Slow	29. Injured
13. Shy	30. Unfit
14. Sensitive	31. Exaggerates Movements
15. Omits Movements	32. Cannot Sustain Movement
16. Has Poor Posture	33. Lacks Focus
17. Lacks Spatial Awareness	

Validity Check

To help demonstrate the validity of the above procedure of data reduction 26% of all data were recoded according to the 72 and 33 item master list. This was an attempt to ensure that the process of data reduction was as objective as possible. It was suggested that coding anything less than one quarter of the data set would be unacceptable.(G. Kysela, 1988, personal communication). The instructions and exact procedure followed by each coder is presented in Appendix C.

In order to infer the inclusiveness of each behaviour category after the merging process had taken place, the master lists were amended to include each additional descriptor which had been collapsed into an existing category. The resulting master lists yielded more information in some categories (See Appendix C). For example, in the skilled list, Category 31, previously identified as Participation - became - more involved in group activities - willingness/motivation to participate in physical activity (frequent participation). In the unskilled list, Category 10, previously identified as Lacks Control - became - poor control of large and or small movements, jerky movements, jittery extraneous movements, choppy, tremor. All of the descriptors were taken from the data set and represented in the same manner that the subjects had generated them.

Agreement scores for the three coders ranged from 75 to 82 percent, with a mean of 80 percent on the skilled data set and from 95 to 97 percent with a mean of 96 percent on the unskilled data set. The fact that there was three times as much information to code for the skilled behaviours can account for some of the range in accuracy. In addition, there were less than half as many categories to learn in the unskilled list as in the skilled list. The agreement scores are still quite high, however, and were accepted as some confirmation that this phase of the data reduction process had been conducted with some care.

As indicated by Sternberg (1986), individuals will provide listings that have some degree of overlap, but not complete overlap. Some of the listed traits or behaviours will be idiosyncratic to particular individuals, others will be common to practically all of the individuals. Therefore, it is necessary to content analyze the behavioural listings, quantifying the number of subjects who list each behaviour or trait, so that merging of like behaviours can proceed. In some cases the conceptual equivalence of different semantic units will be obvious, and in others it will be difficult to determine. Since no clear description of this methodology was available to the researcher, the check on the data reduction process used here was devised largely to ensure that the researcher was not creating a new data set of her own design. In the following chapter the results of the computer analyses conducted on the master list will be reported and discussed.

CHAPTER IV

RESULTS AND DISCUSSION

It was shown in the previous chapter that implicit knowledge of skilled and unskilled behaviour could be demonstrated. The resulting master lists of 72 (skilled) and 33 (unskilled) behaviour characteristics represent the views held in common by the four sample groups of library users, physical education majors, novice and expert jazz dancers. Examination of the frequency distribution of characteristics listed by the total sample will afford an initial answer to the second research question. "What is the nature of implicit knowledge of skilled and unskilled behaviour?"

The Nature of Implicit Knowledge of Skilled Behaviour

A complete frequency distribution for each of the 72 variables in the skilled list is presented in Appendix D. For ease of description, the 20 most frequently chosen characteristics which are listed below in Table 10, will be considered. Although many subjects provided descriptions which were longer, most variable categories were reduced to one or two-word responses for ease of listing. In most cases the descriptors give a clear indication of what the subjects envisaged, however, some additional information may be helpful in differentiating the meanings attributed to the following characteristics: *skilled*, *fit*, and *knowledgeable*. *Skilled* referred to specific qualities of action such as planned, precise, accurate, and consistent. *Fit* related more to good physical ability, a healthy cardiovascular system and the physiological qualities that allow one to become skilled. *Knowledgeable* referred specifically to the understanding that a performer has for the technical aspects of the sport and how these can best be met by the actor.

Table 10

The 20 Most Frequently Listed Characteristics Of Skilled Behaviour

Behaviour	Frequency	Behaviour	Frequency
1. Graceful	97	11. Deterministic	30
2. Confident	60	12. Stable	25
3. Coordinated	59	13. Agile	23
4. Erect	44	14. Musical	23
5. Flexible	41	15. Muscular	23
6. Rhythmical	41	16. Dedicated	22
7. Dynamic	39	17. Happy	22
8. Strong	37	18. Knowledgeable	20
9. Skilled	32	19. Lean	18
10. Fit	30	20. Focused	18

As can be seen from Table 10 the descriptor *graceful* was listed more than any other behaviour characteristic by a large margin. *Confident* and *coordinated* were chosen equally as the next most frequent characteristics of skilled behaviour. The words from the old television commercial, "look sharp, feel sharp, be sharp," provide an interesting metaphor of analysis here. That is, being skilled has a great deal to do with feeling skilled, but above all with looking skilled. The next five choices, *erect*, *flexible*, *rhythmical* , *dynamic,* and *strong* were chosen with similar frequency and all have a distinctly observable quality to them. Perhaps this is an interesting way of describing the most frequent choices made by the sample. Fourteen of the 20 most frequently generated characteristics of skilled behaviour have a distinctly procedural nature, whereas the following 6 characteristics: *confident*, *deterministic*, *dedicated*, *happy*, *knowledgeable*, and *focused*, tend to depict a quality of mind or emotion.

The stability of these choices can be examined by comparing the 10 most frequently generated behaviour characteristics across the four groups, library users, physical education majors, novice and expert dancers. As illustrated in Figures 1, 2, 3, and 4 respectively, the descriptor *graceful* was a unanimous first choice for each group, although it shared that distinction with *flexible* in the expert dancers' choices. There were four characteristics which were shared by all four groups: *graceful*, *confident*, *coordinated*, and *rhythmical*. The library users and physical education majors felt that skilled performers were graceful and confident most often, whereas the two dance groups felt that skilled performers were graceful and/or flexible and coordinated most often. The descriptors, *skilled*, *flexible*, *strong*, and *erect* were chosen by three out of the four groups. The library users and physical education majors both selected *fit* and *agile* while the two dance groups chose *dynamic* and *musical*. Novice jazz dancers were unique in choosing *happy* as a characteristic, and physical education majors chose *stable* and *egotistic* more often than the other three groups. The library group was the only one to choose *deterministic* and *focused* as two of its top 10 behaviour characteristics. As was evident in the frequency distribution for the total sample, descriptors of a procedural nature were much more common than those of an affective nature. The library group made three selections in this category, whereas physical education majors and novice jazz dancers made two, and experts made one.

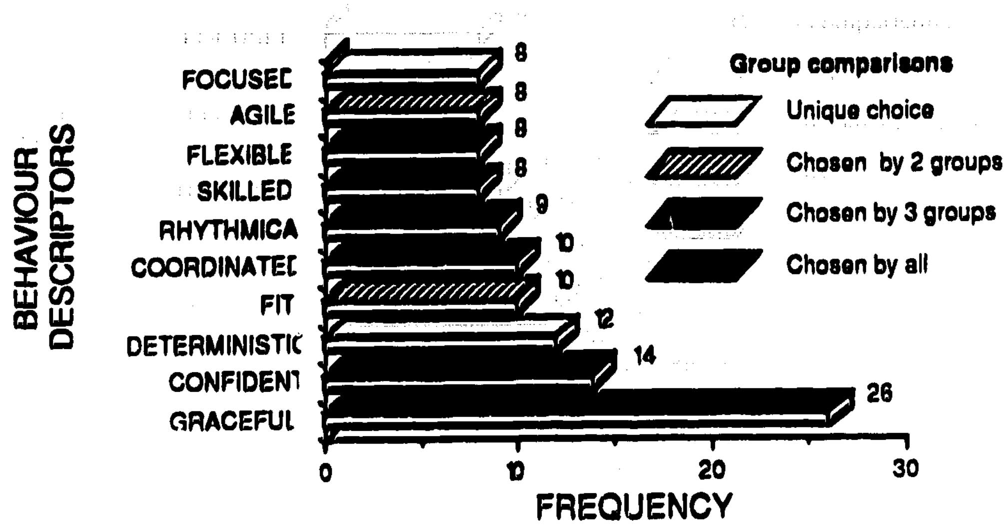


Figure 1. Most frequent characteristics of skilled behaviour generated by the library users.

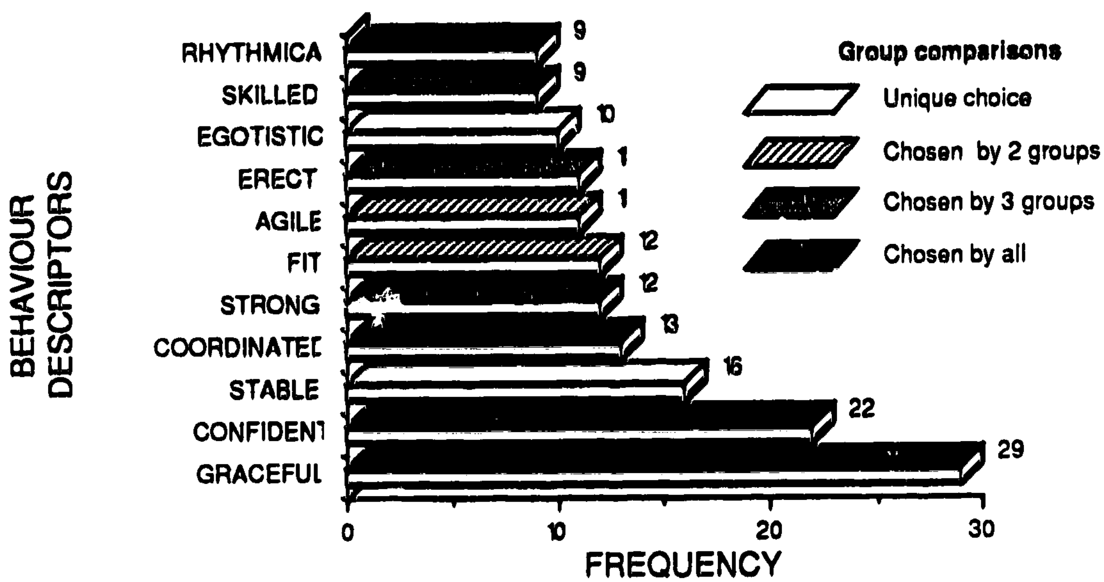


Figure 2. Most frequent characteristics of skilled behaviour generated by the physical education majors.

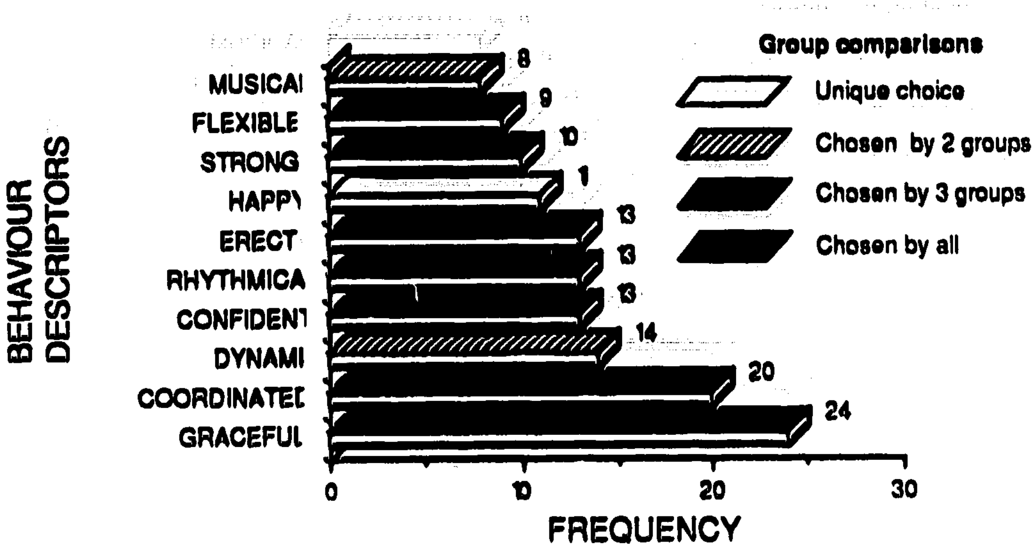


Figure 3. Most frequent characteristics of skilled behaviour generated by novice jazz dancers.

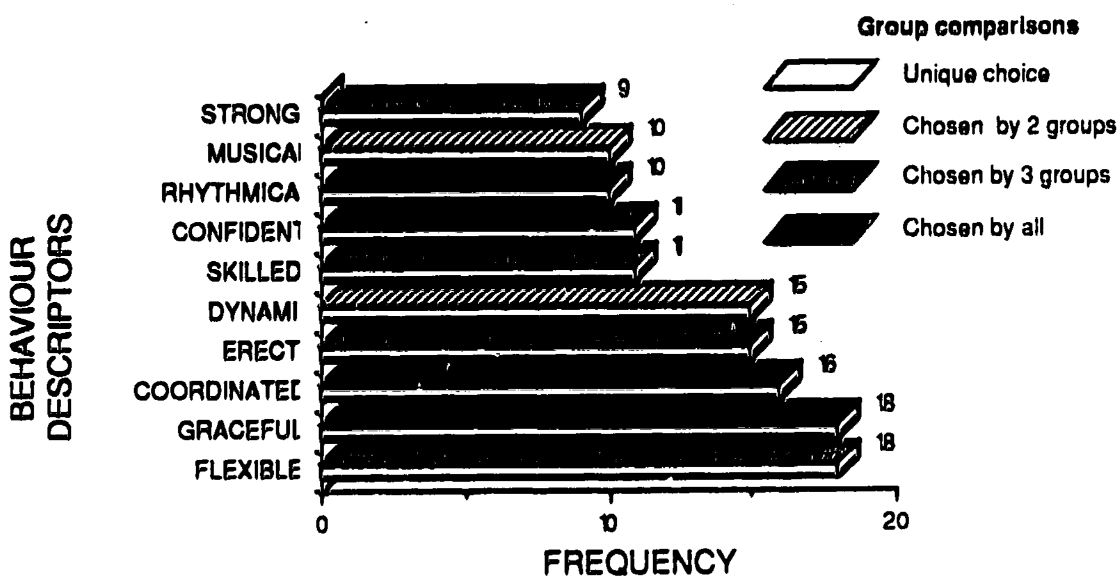


Figure 4. Most frequent characteristics of skilled behaviour generated by the expert jazz dancers.

Table 11 shows the Pearson correlation coefficients generated by comparing the frequencies of choice of each of the four groups on all 72 variables. As could be expected from the above description of most frequent choices, there was a high positive relationship between each of the groups, which ranged from .59 to .84. The highest relationship was between expert and novice dancers (r=.84; p<.0001), whereas the lowest was between expert dancers and physical education majors (r=.59; p<.0001), followed closely by expert dancers and library users (r=.60; p.<.0001). The library users, physical education majors and novices all shared a fairly similar positive relationship. Library and physical education majors were most similar (r=.79; p<.0001), whereas novices and physical education majors, and novices and library users were least similar (r=.76; p<.0001).

Table 11

Correlations Between Frequencies of Skilled Behaviours By Group

Group	Library	Phys. Ed.	Novice	Expert
Library	------	.79	.76	.60
Phys. Ed.		------	.76	.59
Novice			------	.84
Expert				------

Note: Correlations are based on frequencies for the 72 skilled behaviours. All coefficients are significant at p<.0001.

The Nature of Implicit Knowledge of Unskilled Behaviour

In order to determine the nature of implicit knowledge of unskilled behaviour a frequency distribution was computed for the 33 variables in the unskilled master list (See Appendix D). For ease of description, those characteristics which were mentioned ten times or more are presented in Table 12. As was done for the skilled data set, one or two word descriptors were used to indicate each behaviour category. It should be mentioned that the descriptor *unsure* referred to unsure or hesitant as far as could be discerned from facial expressions or attitude, whereas *hesitant* referred to the uncertainty that was shown by pausing before or during an action, or carrying the action out in a very tentative way.

Table 12

Most Frequently Listed Descriptors of Unskilled Behaviour

Behaviour	Frequency	Behaviour	Frequency
1.Awkward	28	8.Hesitant	13
2.Unsure	28	9.Slow	13
3.Uncoordinated	23	10.Lacks control	11
4.Inflexible	18	11.Unmotivated	11
5.Lacks Rhythm	15	12.Has Poor Body Image	11
6.Shy	15	13.Has Poor Posture	10
7.Lacks Balance	14	14.Lacks Automaticity	10

As can be seen by Table 12, the descriptors *awkward* and *unsure* were chosen most frequently, while *uncoordinated* was third in order. An interesting comparison can be made here between these choices and the top three choices in the skilled list. *Graceful, confident* and *coordinated* appear to be the exact opposites of *awkward* , *unsure* and *uncoordinated.* Three of the following four choices, *inflexible, lacks rhythm* and *lacks balance* tend to be of the directly observable nature, whereas *shyness* is something inferred from a person's motor response. As was the case in the most frequent choices for skilled behaviours, most of the descriptors belonged to the former category, while *unsure*, *shy*, and *unmotivated* are of a metacognitive and affective nature.

Examination of the most popular choices of each of the four groups, library users, physical education majors, novice and expert dancers can give some indication of the stability of implicit knowledge of unskilled behaviour for the total sample. As illustrated in Figures 5, 6, 7, and 8, although there is a definite flavour of unskilled behaviour in each of the groups' selections, there is much less congruence between groups than was shown for the skilled lists. In fact each group chose a different characteristic most often and the only two characteristics shared by all groups in the most frequent lists were *awkward* and *unsure*. *Uncoordinated* was the most popular choice in the library group. This descriptor was also chosen by the expert and novice dancers, although the actual frequencies for this characteristic and of all selections in the novice group were low compared to the other three groups. Three descriptors, *lacks balance*, *lacks rhythm* and *hesitant* were shared by two groups. *Awkward* was the most frequent choice of the physical education majors. The profile presented by this group was unusual in that four of their top six choices were unique when compared to the other groups and three of their choices related to difficulty in planning or affect, that is, *unsure*, *shy*, and *unmotivated*. In every other group, *unsure* was the only frequent choice in this category of behaviour.

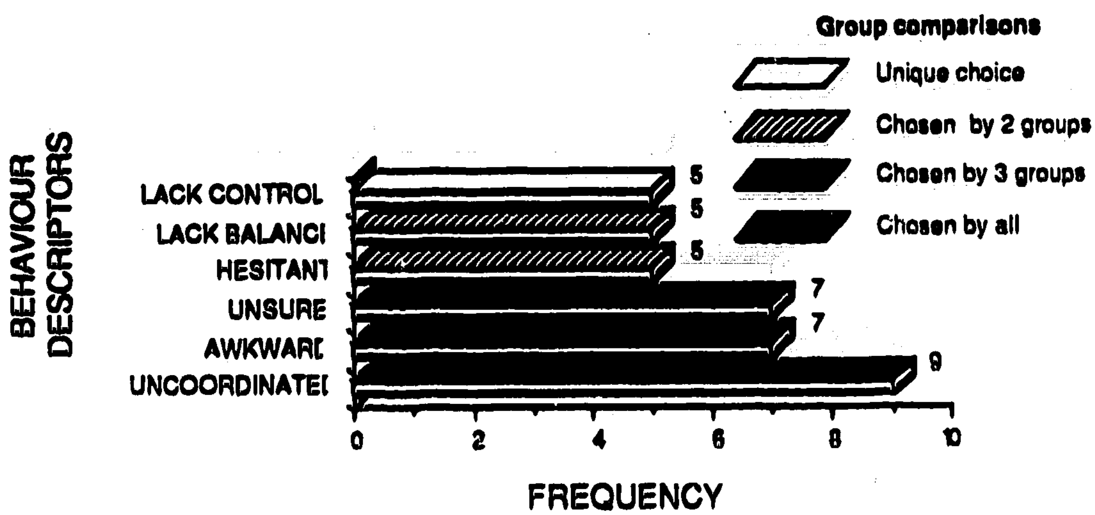


Figure 5. Most frequent characteristics of unskilled behaviour generated by library users.

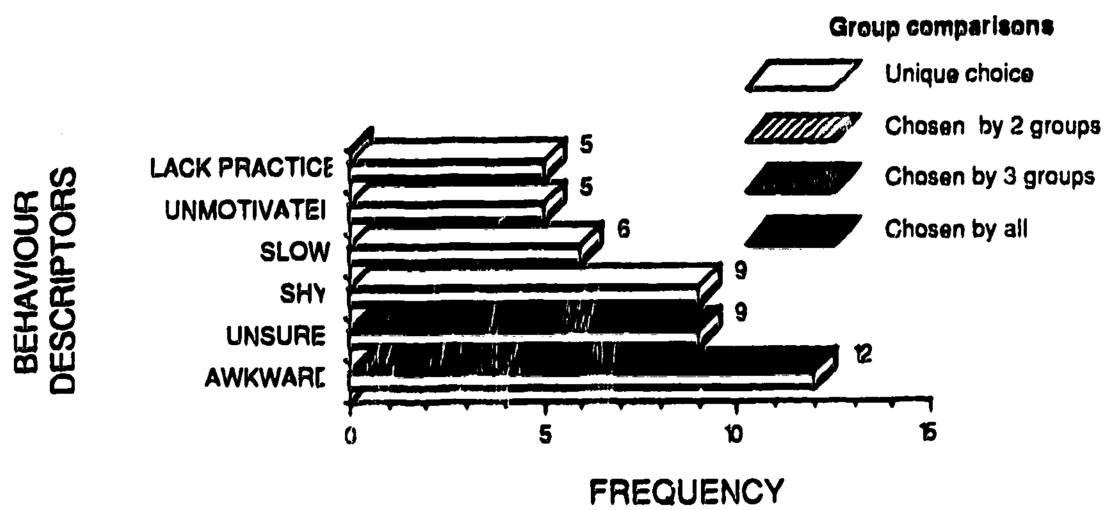


Figure 6. Most frequent characteristics of unskilled behaviour generated by the physical education majors.

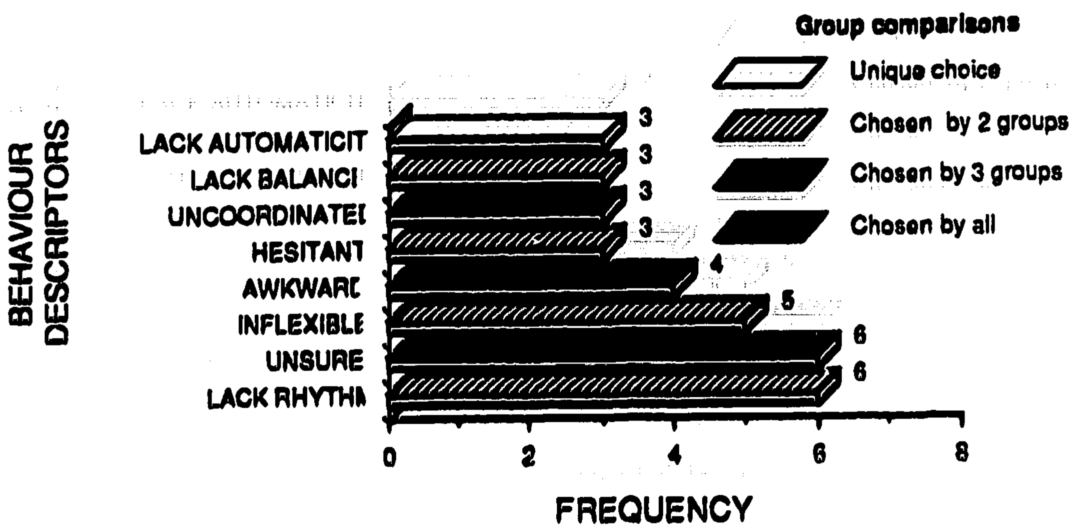


Figure 7. Most frequent characteristics of unskilled behaviour generated by novice jazz dancers.

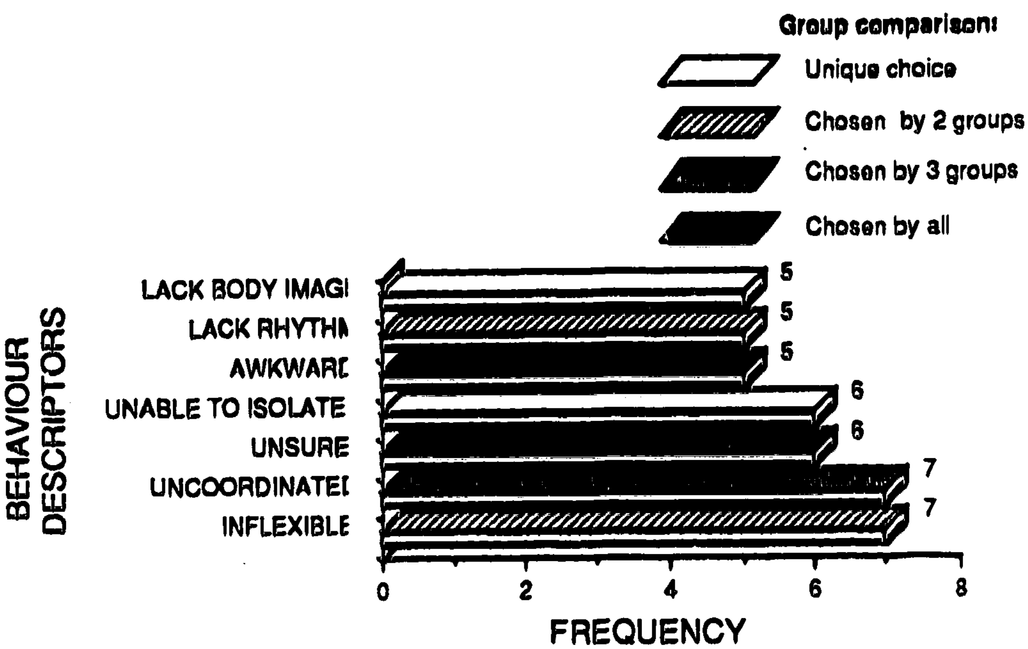


Figure 8. Most frequent characteristics of unskilled behaviour generated by expert jazz dancers.

Table 13 shows the Pearson correlation coefficients for the four groups on the 33 unskilled behaviour characteristics. A somewhat similar configuration of results to those described for skilled behaviour is evident here. There was a positive relationship between each of the groups which ranged from .40 to .68. The highest relationship was again between expert and novice dancers (r=.68; p<.0001), whereas the lowest was between expert dancers and physical education majors (r=.40; p<.01), followed closely by novice dancers and physical education majors (r=.42; p<.01). The library users group had a fairly strong positive relationship with all other groups, ranging from .51 (p<.001) with expert dancers to .60 (<p.0001) with novice dancers. Although there is clear evidence that the views of these four groups are similar, there is also a suggestion that their conceptions of unskilled behaviour differ to some extent, particularly with respect to the physical education students and dancers.

Table 13

Correlations Between Frequencies of Unskilled Behaviours By Group

Group	Library	Phys. Ed.	Novice	Expert
Library	-----	.55***	.60***	.51**
Phys. Ed.		-----	.42*	.40*
Novice			-----	.68***
Expert				-----

*** p<.0001 ** p<.001 * p<.01

Discussion

It is clear from the above analysis that the implicit knowledge of skilled behaviour demonstrated by the four groups in this study bears a very close resemblance to the explicit descriptions of skilled behaviour documented by the theoreticians. In fact, for each of the following descriptors which was presented in the literature: fast, accurate, consistent, coordinated, efficient, confident, intuitive or displaying implicit knowledge, having the ability to solve action problems, and spending long hours in practice; there was a corresponding characteristic generated in the behaviour list. These results comply with the conclusions made by Sternberg et al. (1981), that implicit theories mirror explicit theories quite closely. Although similar characteristics were documented, the implicit theories seem to place a large emphasis upon coordination and confidence above many of the other descriptors. Skilled people know how to perform, they have procedural knowledge. Skilled people know when an action will be successful in a particular situation, they have metacognitive knowledge.

The most common aspect of skilled behaviour mentioned, *gracefulness*, is one that the experts tend to take for granted. Gardner acknowledges it when he says, "Knowledge of what is coming next allows that overall smoothness of performance which is virtually the hallmark of expertise." (1983, p. 209). Perhaps the term does not seem to be scientific enough, and yet seldom do we see skilled action that we would say lacked grace. It could be that the choice of this particular descriptor is an artifact of the questioning format, since people were asked to document observable characteristics. It could also be argued that two of the three domains were related to dance and movement, where it might be expected that grace would be a dominant factor. However, grace was also the top choice of physical education majors and library users when skill domains were pooled and was second only to confidence in all descriptors for athletes. In stating the obvious, it is possible therefore that implicit theories have drawn attention to an aspect of skilled behaviour which should be more carefully studied.

A second point of comparison which helps to depict the nature of implicit knowledge in this study is provided by examination of the views held by each group. The views expressed are largely held in common by all groups. Not only do the correlations in Table 11 indicate a strong positive relationship between all groups, but the frequency data show that these coefficients are based on a core of four common characteristics. It is also fairly clear that the expert and novice dancers share views of skill which are influenced by their specific skill domain. The emphasis placed on the need for dynamic, flexible, and musical qualities in skilled action clearly relates to the domain of dance. In contrast, the physical education majors and library users tended to emphasize those procedural qualities more often associated with athletes. Library users who could be considered the least highly skilled of the four groups were consistent in their recognition of the need for goal directed and planned behaviour. In summary, there is strong evidence of a common base of implicit knowledge of skilled behaviour which varies somewhat depending on the skill orientation of the group providing the information.

In examining the nature of implicit knowledge of unskilled behaviour provided by analyzing the above frequencies and correlations, it is apparent that explicit and implicit theories are highly comparable. As was shown in the characteristics generated for skilled behaviour, every descriptor detailed in the literature was mentioned by the groups answering the question on lack of skill. There was a tendency to use several specific descriptors to depict poor execution of skills, such as *slow*, *hesitant*, and *exaggerated* There was considerable emphasis on the inability to plan actions or conversely, the need to plan even simple actions as shown in the descriptors *unsure*, *requires effort*, and *lacks automaticity*. The third area of concentration also well documented in the literature, was affect. This aspect of unskilled behaviour was illustrated by the descriptors *shy*, *unmotivated* and *lacks practice*.

Perhaps the most notable observation to be made is the direct comparison between descriptors of unskilled and skilled behaviour. As was noted earlier, the top three descriptors from both behaviour lists are exact opposites. *Awkward, unsure* and *uncoordinated* are the negative counterparts of *graceful, confident*, and *coordinated*. In addition, careful examination of the most frequent choices given in Tables 10 and 12, revealed that there were 10 characteristics listed for unskilled behaviour which had exact opposites in the skilled list. Although the emphasis is not as pronounced as it is in implicit theories of skilled behaviour, there is still a clear impression that lack of smooth execution (awkwardness) is the most notable feature in implicit theories of unskilled behaviour. Good motor pattern consistency, therefore, or procedural knowledge is at the root of skilled behaviour.

Group comparison of implicit theories of unskilled behaviour revealed a similar pattern to the results with skilled behaviours. Expert and novice dancers had the most similar views, and tended to isolate characteristics that related to the dance domain, such as *lack of rhythm, inflexibility*, and *inability to isolate.* The one comparison that was different from the analysis of group theories of skill was the low relationship between novices and physical education majors. As was noted earlier, the physical education group emphasized the negative affective and poor metacognitive knowledge of unskilled performers much more than any other group. The lower between-group correlations for the physical education students may be a result of these observed differences. Less significant relationships overall may also have resulted from a smaller total subject number (61). Despite these observed differences in implicit theories, there is a remarkable similarity in group views of skilled and unskilled behaviour which compare readily to explicit theories.

The Nature of Movement Intelligence

It is essential now that the nature of implicit knowledge of skilled and unskilled behaviour has been established, that the concept of movement intelligence be examined. Recall that the research paradigm adapted from Sternberg et al. (1981) had equal numbers from each of the four subject groups responding to one of three questions concerning either athletic skill, dancing skill or movement skill. The assumption was made that skilled behaviour could be modeled by these three components. Table 14 lists those characteristics which were selected most often in answering each question.

Table 14

Most Frequent Selections for Each Component of Movement Intelligence

Athletic Skill		Dancing Skill		Movement Skill	
1. Confident	22	Graceful	41	Graceful	37
2. Graceful	19	Rhythmical	22	Coordinated	25
3. Coördinated	17	Dynamic	18	Confident	23
4. Strong	16	Coordinated	17	Erect	22
5. Muscular	15	Flexible	17	Rhythmical	6
6. Deterministic	14	Musical	16	Flexible	12
7. Flexible	12	Confident	15	Agile	11
8. Dynamic	11	Strong	14	Happy	11
9. Dedicated	11	Erect	13	Dynamic	10
10. Knowledgeable	11	Skilled	13	Skilled	10
11. Focused	11	Deterministic	13	Fit	10

As was illustrated in the overall frequency data of characteristics of skilled behaviour, the descriptor *graceful* was a common choice. *Graceful* was chosen most frequently in describing both skilled dancers and people who move well. It was chosen second to *confident* in describing skilled athletes. In addition to ***graceful*** and ***confident***, the descriptors ***flexible***, ***dynamic***, and *coordinated* were shared by all three movement intelligence components. In addition, *rhythmical*, *skilled*, and ***erect*** were characteristics shared by skilled dancers and people who move well, whereas *strong* and ***deterministic*** were characteristics common to both skilled athletes and skilled dancers. It is interesting to note that characteristics of a procedural nature were again most frequent, however, 5 of the behaviours listed for skilled athletes were either of the affective or metacognitive variety. There were only two selections in this category for skilled dancers and people who move well. It is clear from this descriptive analysis and also from the correlation matrix presented below that there is a strong positive relationship between all three components of movement intelligence.

Table 15

Correlations Between Frequencies of Movement Intelligence Components

Component	Athletic Skill	Dancing Skill	Movement Skill
Athletic Skill	------	.60	.61
Dancing Skill		------	.84
Movement Skill			------

Note: Correlations are based on frequencies for the 72 skilled behaviours.
All coefficients are significant at $p<.0001$.

Table 15 illustrates the overall correlations between the components of movement intelligence, that is, athletic skill, dancing skill and movement skill. As can be seen from the table the strongest relationship exists between dancing skill and movement skill. Athletic skill is equally related to dancing skill and movement skill, although the relationship is not as strong as that between dancing and movement. In order to determine how the nature of movement intelligence might change according to group membership separate correlations were conducted on the responses of each group for each of the components.

Table 16

Correlations of Movement Intelligence Components By Group

Component Group	1	2	3
Library			
1. Athletic Skill	------	.22*	.26**
2. Dancing Skill		------	.61***
3. Movement Skill			------
Physical Education Majors			
1. Athletic Skill	------	.45***	.51***
2. Dancing Skill		------	.70***
3. Movement Skill			------
Novice Dancers			
1. Athletic Skill	------	.60***	.58***
2. Dancing Skill		------	.74***
3. Movement Skill			------
Expert Dancers			
1. Athletic Skill	------	.54***	.59***
2. Dancing Skill		------	.64***
3. Movement Skill			------

* $p<.01$, ** $p<.001$, *** $p<.0001$

It is apparent from Table 16 that the configuration of correlations for each group closely resembles that of the overall correlational data. That is, in each group the highest relationship exists between frequencies of dancing skill and movement skill, and the relationship of athletic skill to both dancing and movement skill is lower and almost equal. However, quick perusal of the actual coefficient values shows that the library group have a fairly different view of athletic skill in relation to everyday movement and in particular to dance skill. Although physical education majors also see dance as least related to athletic skill (r=.45; p<.0001), this relationship is much stronger than in the library group (r=.22; p<.01). Novices are unique in that they recorded the highest correlation between dance and movement skill (r=.74; p<.0001) and also showed the highest relationship between athletic, dancing and movement skill. The expert dancers, unlike the library group, see a closer relationship between all components of movement intelligence, that is, for them, athletic skill, movement skill and dancing skill are all moderately related.

Discussion

The nature of movement intelligence described in this study is clearly illustrated by the descriptors chosen for each component and shown in Table 14. All three components share a common base of procedural and affective characteristics, although the relative weight of emphasis in each domain is different. In addition, each domain stresses particular elements which define its unique qualities. Skill in moving well is typified by erect posture, a noticeable rhythm, and an air of well-being or happiness. Dancing skill requires an even stronger element of rhythm particularly in relationship to music and a sense of determinism and energy in both action and attitude. Athletic skill is characterized by strength of movement, musculature and attitude, but is most obviously unique in its requirements for knowledge of the task requirements and ability to plan and perform in a successful way.

The correlation coefficients presented in Table 15 confirm that the relationships between the three components of movement intelligence are highly significant. It is logical to expect this result when considering any specific domain, however, the ordering of the relationships should also vary accordingly. If the domain under study were soccer skill, for example, we would expect a higher relationship between athletic skill and this particular domain and a lower relationship to movement skill.

Unlike the results of Sternberg's (1981) initial study, the order of relationships in this study is remarkably consistent. As shown in Table 16, for each of the four groups the conception of movement intelligence is similar. There is a moderately high relationship between movement and dancing skill and athletic skill is equally, but less related to movement and dancing skill. Sternberg found that the library users or students in his study saw no relationship between general intelligence and practical intelligence, whereas the commuters and supermarket patrons felt this was the strongest relationship. In addition, these same two groups saw no relationship between general intelligence and academic intelligence. Clearly there was a discrepancy of views in Sternberg's study which was not evident in this study.

Some mention must be made, however, of the relatively low correlations computed for the library sample. Investigation of these lower values indicated that a low frequency of behaviours generated for both the athlete and moves well conditions by the library group, and a higher number of characteristics generated for the dance skill condition could account for some of the discrepancy here. In addition there was a much smaller spread in the characteristics generated for skilled athletes. That is the library users have a similar view of athletic skill, but a narrower view.

The concept of movement intelligence, it could be argued, is a somewhat arbitrary construct which was adapted from Sternberg's work on the triarchic theory of intelligence (1985). Sternberg was able to provide considerable support for his triarchic theory by showing through factor analysis that verbal ability, problem solving ability and practical or social competence accounted for 51 percent of the variance in people's conceptions of intelligence (Sternberg et al., 1981). It was not expected that the implicit theories of skilled and unskilled behaviour generated in this study would fall neatly into the theoretical package proposed at the outset in the knowledge-based model. However, the three components of movement intelligence, athletic skill, movement skill, and dancing skill, do seem to more adequately encompass the elements of skilled behaviour which are emphasized by the Wall model. Athletic skill is the embodiment of generally efficient motor behaviour which permits prediction, problem solving and application of suitable strategies in many sport situations. Movement skill, on the other hand, depicts the proficiency required to perform normal, everyday ambulatory actions and complete common, habitual, manipulative tasks. Domain specific skill, in this case dancing skill, is a separate component. It reflects the expertise necessary to excel in a particular domain as the result of highly tuned interaction of the knowledge bases. It is the writer's contention that the concept of movement intelligence provides a more effective means of illustrating the interaction of the knowledge bases on an individual level than has been presented by the model to date.

The Nature of Metacognitive Knowledge and Self Ratings on Skill

In the previous section it was established that considerable agreement exists between the skill groups represented in this study concerning the construct movement intelligence. For the most part it can be said that the characteristics which define each component vary somewhat, but not greatly according to the skill group generating the behaviours. All three components, movement skill, athletic skill and dance skill, share a common base of characteristics but also comprise elements which are unique to the type of skill required by the domain. That is, there is a prototype of the skilled performer which has some universality and there is some consensus of the qualities needed to be successful in a particular context.

Such a high level of agreement would not be expected when people are reporting on their own skill level in a particular domain. If there are real differences in the performance capabilities of particular skill groups in a specific domain, then group self ratings should reflect these differences and vary accordingly. The opportunity to investigate this assumption was provided by comparing differences in group self ratings on each of the three components of movement intelligence.

A one-way analysis of variance was applied to compare group skill level (library users, physical education majors, novice and expert dancers), and mean self ratings on a 9-point scale for movement skill, dancing skill and athletic skill. A significant main effect, $\underline{F}(3,239) = 20.94$, $\underline{p}<.00001$, was obtained for ratings on movement skill. Multiple comparisons using the Scheffé procedure determined that novice dancers rated themselves significantly lower on movement skill than the 3 other groups and library users ranked themselves significantly lower than both expert dancers and physical education majors were. All Scheffé tests were significant at $\underline{p}<.05$. Physical education majors and expert dancers gave themselves the highest mean ratings on movement skill.

Analysis of the dance skill ratings yielded a significant main effect, $\underline{F}(3,239) = 16.56$, $\underline{p}<.00001$. Scheffé tests ($\underline{p}<.05$) indicated that expert dancers rated themselves significantly higher than all other groups on dancing skill. As is evident from Table 17, a significant main effect, $\underline{F}(3,239) = 17.91$, $\underline{p}<.00001$, was also obtained from the analysis of athletic skill ratings. Multiple comparisons indicated that physical education majors ranked higher in athletic skill than all other groups. Expert dancers also rated themselves significantly higher than novice dancers in this skill domain. Scheffé tests were significant at $p<.05$.

Table 17

Analysis of Variance for Group Self Ratings on Skill

Skill Rating Source	df	MS	F	p
Movement Skill				
Between Groups	3	33.3533	20.94	.00001
Within Groups	239	1.5928		
Dancing Skill				
Between Groups	3	45.0419	16.56	.00001
Within Groups	239	2.7207		
Athletic Skill				
Between Groups	3	34.0807	17.91	.00001
Within Groups	239	1.9028		

It is clear from the above analyses, that distinct, measurable differences exist in the metacognitive knowledge of these four different skill groups which are also in keeping with their perceived differences in skill. It is possible, however, that the self ratings could have been affected by the particular skill component for which each person generated behaviours. That is, equal numbers from each of the four skill groups generated behaviour characteristics for either one of the three components of movement intelligence or the single dimension of unskilled behaviour. In order to investigate this hypothesis a 4(skill groups) x 4(skill questions) analysis of variance was used with the mean rating scores on movement, dancing and athletic skill as the dependent variables. Results of this analysis are presented in Appendix E.

Results of the analyses on dance and athletic skill ratings were unchanged. There were significant main effects for skill group identical to those previously reported. There were no effects for question and no interactions. Analysis of movement skill ratings provided a different picture. Significant main effects both for question, $\underline{F}(3,227) = 2.93$, $\underline{p}<.035$, and for group, $\underline{F}(3.227) = 21.37$, $\underline{p}<.00001$, were obtained. Scheffé multiple comparison tests revealed that those people who were asked to list behaviour characteristics for skilled dancers tended to rank themselves significantly lower on movement skill than those who provided behaviour characteristics for skilled athletes and people who are unskilled $\underline{F}'(3,227) = 4.82$, $\underline{p}<.01$.

Discussion

The comparisons of self ratings on movement, dance and athletic skill help to confirm that real differences exist in the procedural knowledge of each group in these three skill domains. Not only do the group self ratings match the perceived level of skill, but the ranking relative to the other groups is logical in every case. Both expert dancers and physical education students rank high on movement skill, but expert dancers exceed all other groups on dancing skill. In keeping with the close relationship that expert dancers saw between dancing and athletic skill, they also ranked themselves significantly higher on athletic skill than the novices. The novice dancers appear to be universal novices in this study, that is, they ranked lowest in all three skill domains.

Additional confirmation of the physical education students' dance skill ratings can be provided by the results of the CDance (Commitment to Dance) questionnaire which all students completed before and after their introductory dance class. Although positive attitudes to jazz and social dance increased over the duration of the course, the general attitude to dance itself and to personal skill level was unchanged. Most students did not enjoy dance, and felt their skill level was low. Although these attitudes can not be generalized to all physical education students, response patterns to these questionnaires have been replicated and appear to be quite stable (Nielsen, 1985).

Since an equal number of subjects from each skill group generated behaviour characteristics for skilled dancers, the lower movement skill ratings which were reported should have been experienced by all four groups. Therefore, the effect on the overall pattern of results in this study is considered to be quite minimal. However, the fact that there was an effect at all is quite important as far as study design is concerned. Even though precautions were taken to systematically vary the questions which subjects answered and the order of the skills on which subjects ranked themselves a small effect was still present. This result should serve as a warning that when doing metacognitive assessment, extreme care must be taken to ensure that the results which are reported are not an artifact of the way the material was presented to the subjects (Ericsson & Simon, 1980).

In summary then it can be stated that implicit theories of skilled and unskilled behaviour closely resemble explicit theories and are largely held in common by different skill groups. The concept of movement intelligence as illustrated in this study seems to have effectively captured both the general requirements of skilled behaviour and the qualities necessary for success in a particular domain. Lastly, metacognitive knowledge as illustrated by self ratings on skill realistically reflects perceived procedural skill differences, and varies in a linear fashion with expertise.

Implicit Knowledge and the Procedural, Affective and Metacognitive Domains

The investigation of implicit knowledge which has been conducted up to this point has closely followed the guidelines established by Sternberg et al. (1981). Following this methodology there is considerable evidence to support the existence of implicit knowledge of movement intelligence. The final questions of interest concern the relationship of people's conceptions of movement intelligence to the knowledge bases outlined by the Wall et al. model (1985). In order to determine how the implicit knowledge of skill generated in this study fits into the definitions of procedural, declarative, and affective knowledge, there will be a noticeable departure from a confirmatory approach to a more exploratory approach to the problem. The heuristic nature of the procedures and analyses which follow is introduced purposefully. It is hoped that this less traditional investigation of the knowledge generated in this study will help to illuminate some of the questions which have developed in previous attempts to illustrate the knowledge-based model, and that this information will provide a framework for future, less tentative research. The first step on this less travelled pathway involved the process of data reduction.

Data Reduction Procedures

Before further analysis was attempted, it was decided to reduce the number of variables from the 72 (skilled) and 33 (unskilled) category sets. The number of variables was large, there appeared to be many that were weak (frequency of 2), and there was a considerable amount of overlap between some characteristics. By choosing a cut-off criterion of 5 it was possible to reduce the number of variables by 25, eliminate the truly unique characteristics, and combine categories which displayed considerable likeness. All behaviours with a frequency lower than 5 were collapsed into more frequently chosen, like-categories. If the behaviours were considered unique, they were deleted. In the skilled data set, 12 behaviour categories were deleted and 12 were joined with larger, like categories. If a subject already had the behaviour included in the variable list, no changes were made in the data set. This resulted in a new, 48-item master list which is presented in Table 18. Although the number of variables is still quite large, the objective was to create a list of behaviour characteristics that was manageable while losing as little meaning as possible from the original list.

A similar process of reduction was followed with the unskilled data set. In applying the frequency criterion of 5 selections or more, there were 3 characteristics deleted from the master list, and 9 collapsed into stronger, like-categories. The resulting master list of 21 unskilled behaviour characteristics is presented in Table 19. Further arbitrary data reduction was discounted in favour of a cluster analysis. Cluster analysis refers to a wide variety of techniques used to group entities (people) into homogeneous subgroups on the basis of their similarities (Lorr, 1983). Since the number and nature of such groups are not known in advance, the clustering process is actually a type of preclassification. The correlational data on skilled behaviour characteristics presented in Table 11 showed high positive relationships among all four skill groups, therefore it was not possible to further classify the data from this perspective. Since it is not necessary in cluster analysis to predict the number of groups or clusters expected, the data can dictate the classification which results. This approach was preferred since the object was to gain as much information as possible without biasing the outcome with some preconceived notion of knowledge categories.

Table 18

Master List of Skilled Behaviours After Reduction

Behaviour	Frequency	Behaviour	Frequency
1. Motivated	10	25. Happy	24
2. Fit	30	26. Mesomorphic	16
3. Competitive	9	27. Graceful	97
4. Durable	15	28. Focused	18
5. Well Practiced	12	29. Confident	60
6. Intelligent	12	30. Naturally Skilled	15
7. Mature	14	31. Optimistic	14
8. Cooperative	14	32. Peaceful	8
9. Deterministic	33	33. Rhythmical	41
10. Egotistic	15	34. Erect	47
11. Knowledgeable	20	35. Stable	25
12. Receptive	7	36. Artisitic	8
13. Lean	18	37. Creative	11
14. Strong	37	38. Knows Body	18
15. Muscular	22	39. Dynamic	39
16. Perceptive	6	40. Well Extended	6
17. Skilled	32	41. Expressive	17
18. Flexible	41	42. Musical	23
19. Fast	17	43. Want to Learn	10
20. Coordinated	59	44. Reacts Quickly	6
21. Agile	23	45. Participates	9
22. Dedicated	22	46. Communicative	6
23. Outgoing	19	47. Dramatic	13
24. Aggressive	8	48. Loves Dance	7

Table 19

Master List of Unskilled Behaviours After Reduction

Behaviour	Frequency	Behaviour	Frequency
1. Hesitant	13	12. Slow	13
2. Inflexible	18	13. Shy	16
3. Awkward	28	14. Has Poor Posture	10
4. Uncoordinated	26	15. Lacks Spatial Awareness	6
5. Requires Effort	15	16. Frustrated	7
6. Makes Strong Moves	6	17. Unmotivated	14
7. Lacks Balance	14	18. Has Poor Body Image	11
8. Lacks Rhythm	15	19. Imitates Others	8
9. Unsure	28	20. Lacks Practice	9
10. Lacks Control	11	21. Unable to Isolate	8
11. Has Poor Gait	9		

Cluster Analysis of Skilled Behaviour Characteristics

Divisive clustering techniques partition the data into two groups and then continue to subdivide it into more meaningful subcategories. In hierarchical clustering once an object has been allocated to a cluster, it is irrevocable. This condition may set up a problem of chaining. That is, the clusters are determined by chains of similar intermediate objects which may tend to obscure the reasonably distinct clusters that do exist (Dillon & Goldstein, 1984). For this reason it was decided to use a K-means partitioning technique designed by Engelman and Hartigan (1975). The program PKM uses the Euclidean distance to measure the distance between each case and the centre of each cluster. Once exclusive clusters have been established, cases are moved from one cluster to another until no transfer of an individual results in a reduction in error. Application of the PKM K-means clustering technique to the 48-item skill characteristics generated by 182 people in the four skill groups yielded the following solution.

Two distinct clusters were identified. Cluster 1 contained 97 cases. The average distance of each case from the centre of Cluster 1 was 2.0108. Cluster 2 contained 85 cases and had an average distance from its centre of 2.0505. As is evident from these average values and from the histograms which follow, there is considerable overlap between the two clusters.

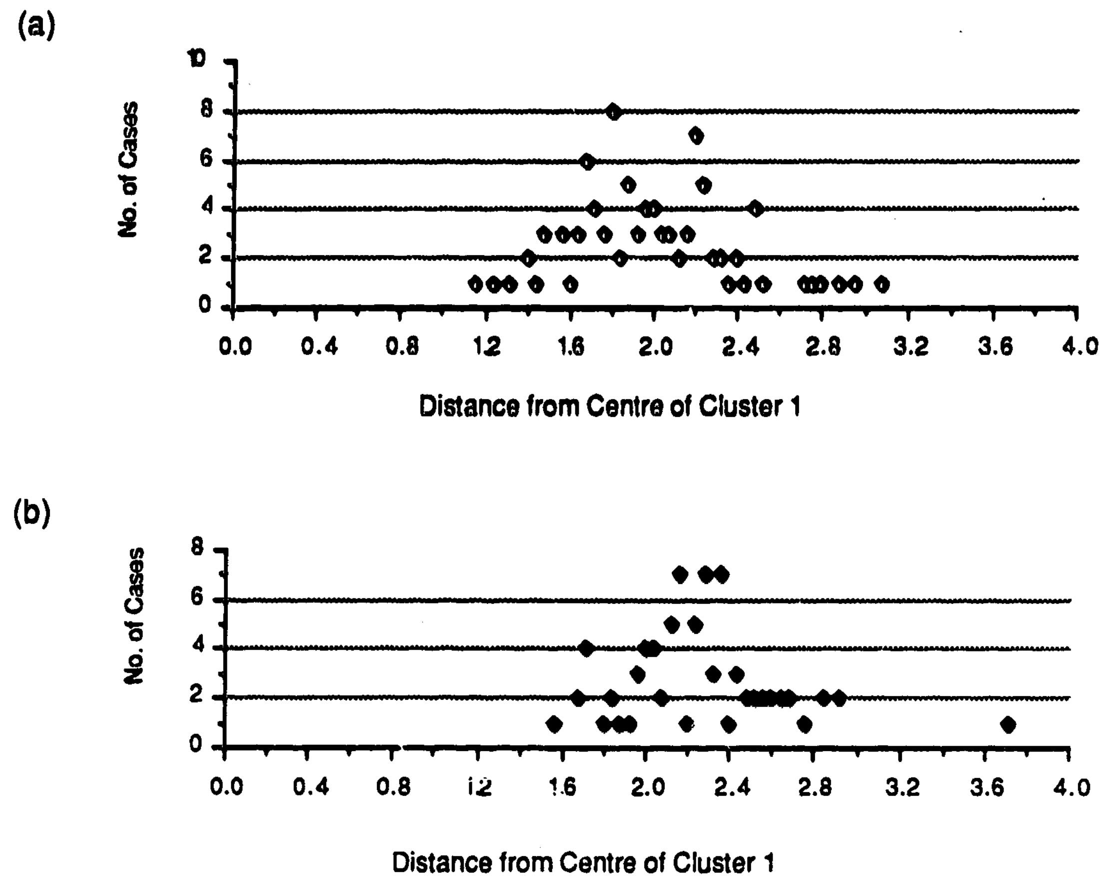
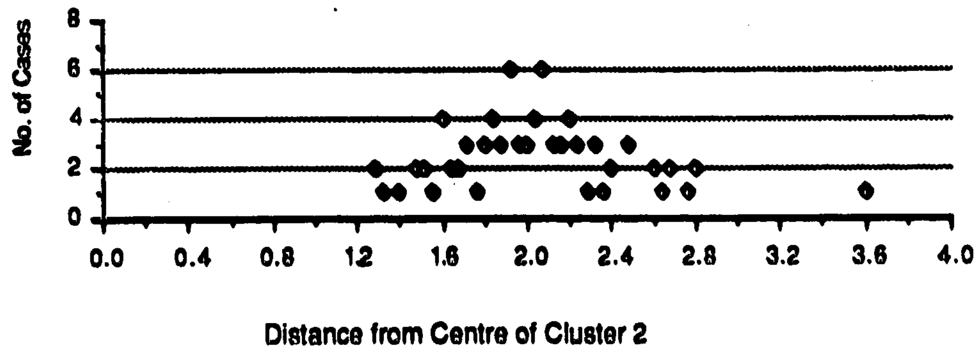


Figure 9. Skilled Behaviour Characteristics: the distance from the centre of Cluster 1 (a) to each case in Cluster 1 and (b) to each case in Cluster 2.

(a)



(b)

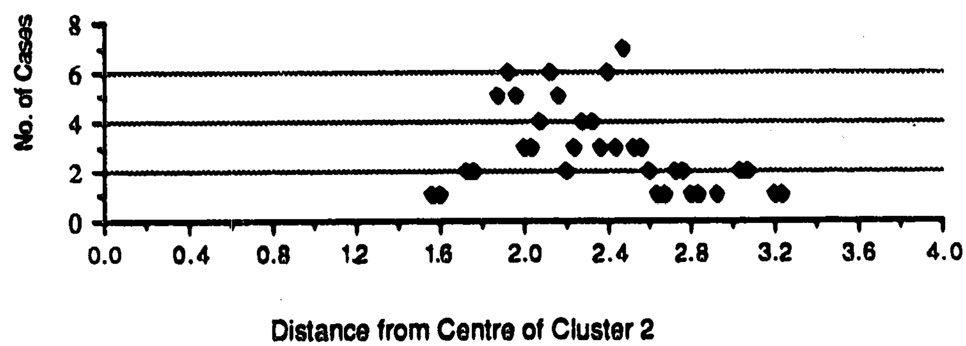


Figure 10. Skilled Behaviour Characteristics: the distance from the centre of Cluster 2 (a) to each case in Cluster2, and (b) to each case in Cluster 1.

The scattergram presented in Figure 11, derived by plotting the orthogonal projection of cases into the plane defined by the centres of the most populous clusters, nicely illustrates the configuration of the two clusters. Cluster means (centres), and within-cluster standard deviations, computed from data in the original scale are presented in Appendix F. An analysis of variance of each variable was computed, comparing the between-cluster mean square to the within-cluster mean square. Table 20 and 21 illustrate the ANOVA results for all variables with significant $\underline{F}$-ratios in Cluster 1 and 2.

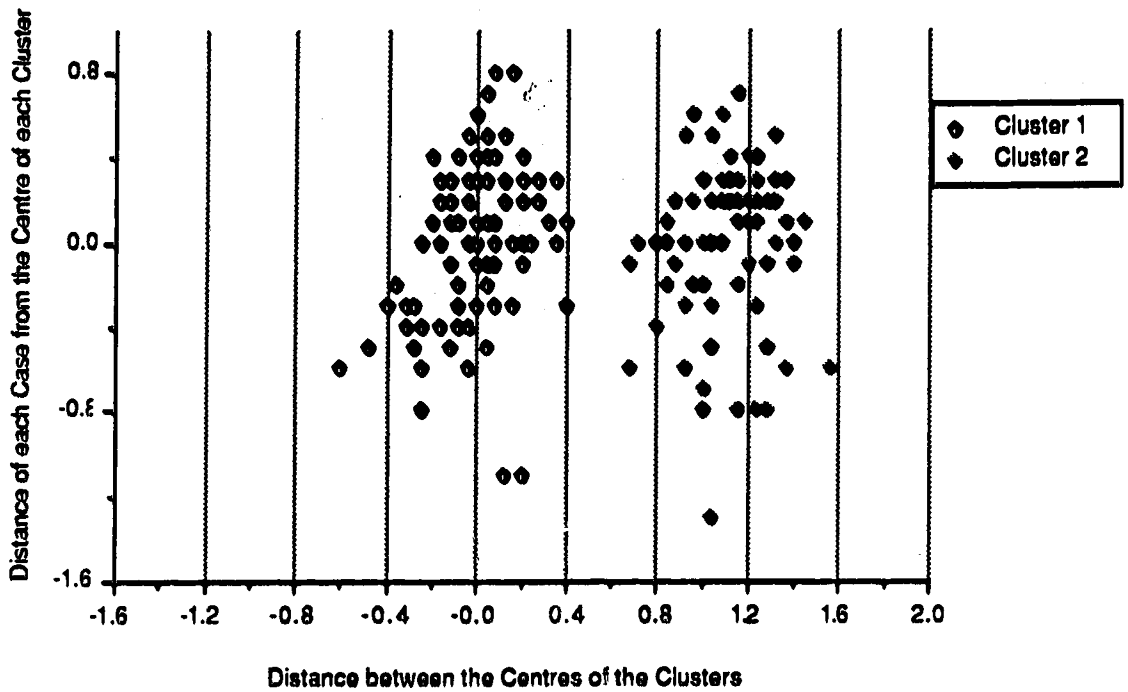


Figure 11. Scattergram showing Cluster 1 and 2 of skilled behaviours.

Table 20

Analysis of Variance for Selected Variables in Cluster 1

Variable (No.)	df Between,Within	MS Between(Within)	F	p
Rhythmical (33)	1,180	1.4651 (.1683)	8.70	.0001
Stable (35)	1,180	.9836 (.1143)	8.60	.0001
Agile (21)	1,180	.7277 (.1076)	6.76	.001
Well Extended (40)	1,180	.1733 (.0313)	5.54	.005
Coordinated (20)	1,180	.9479 (.2162)	4.38	.01

The five variables listed in Table 20 are the behaviours that tend to define the responses of people in Cluster 1. That is, the Cluster 1 means for

rhythmical, stable agile, well extended and ***coordinated*** are significantly greater than the Cluster 2 means. There is an unmistakable procedural quality to Cluster 1, which seems to relate at least on the surface to good skill form. In Cluster 2, on the other hand the 8 marker variables tend to be both affective and metacognitive in nature and relate quite strongly to a general quality of involvement (***outgoing, participates, well practiced***) and planned action (***motivated, focused, intelligent, deterministic***). There is a suggestion with the inclusion of ***naturally skilled*** that the skilled not only are motivated to practice in the right way, but possess a genetic predisposition for skilled action.

Table 21

Analysis of Variance for Selected Variables in Cluster 2

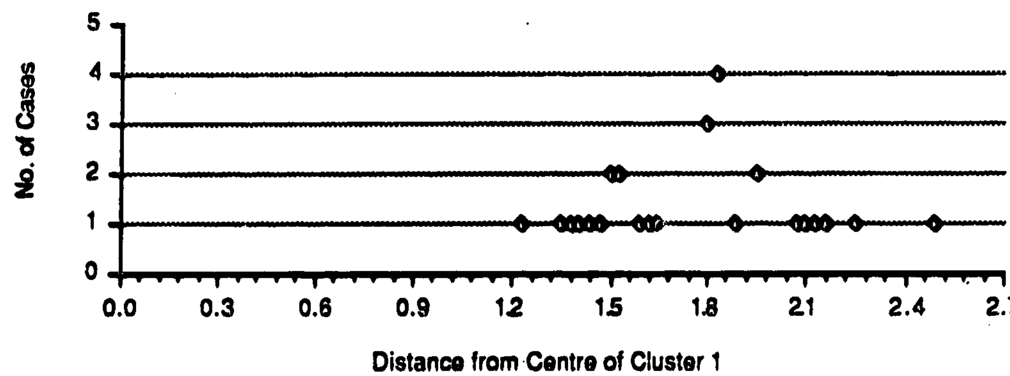
Variable	df Between,Within	MS Between(Within)	F	p
Outgoing	1,180	.5800 (.0913)	6.35	.002
Participates	1,180	.2351 (.0412)	5.71	.004
Focused	1,180	.4656 (.0875)	5.32	.006
Motivated	1,180	.2447 (.0511)	4.79	.009
Naturally Skilled	1,180	.3522 (.0745)	4.72	.010
Intelligent	1,180	.2545 (.0609)	4.18	.017
Well Practiced	1,180	.2545 (.0609)	4.18	.017
Deterministic	1,180	.4640 (.1475)	3.15	.045

Cluster Analysis of Unskilled Behaviour Characteristics

A similar procedure was followed in attempting to classify the unskilled behaviour characteristics. Application of the PKM program to the unskilled behaviour lists generated by the 61 people in the sample yielded the following solution. Two distinct clusters were identified. Cluster 1 contained 29 cases. The average distance of each case from the centre of cluster 1 was 1.7735.

Cluster 2 contained 32 cases and had an average distance from its centre of 1.6767. As is evident from these average values and from the histograms which follow, there is considerable overlap between the two clusters. Figure 12 displays the distance from the centre of Cluster 1 to each case: a) for cases which are in the cluster, and b) for cases which are not in the cluster. Figure 13 similarly displays the distance from the centre of Cluster 2 to each case: a) for cases in Cluster 2, and b) for cases in Cluster 1.

(a)



b)

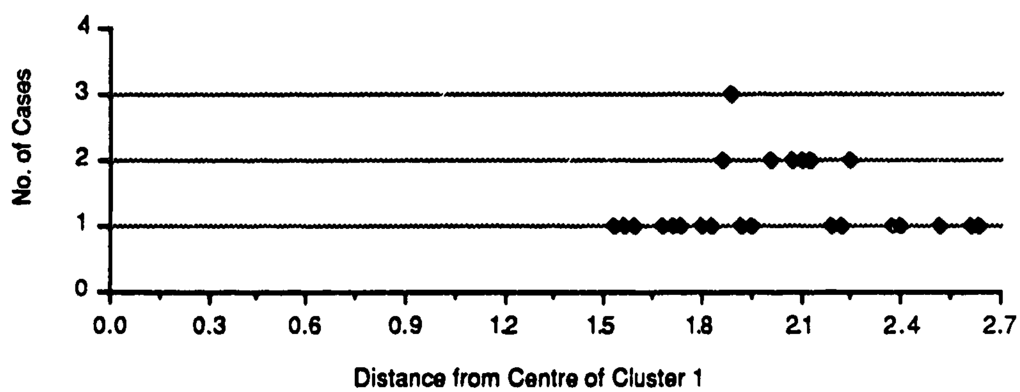
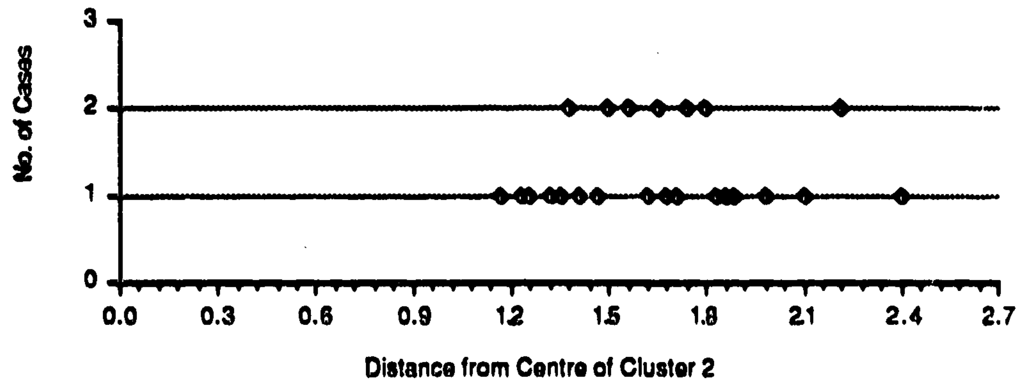


Figure 12. Unskilled Behaviour Characteristics: The distance from the centre of Cluster 1 a) to each case in Cluster 1 and b) to each case in Cluster 2

(a)



(b)

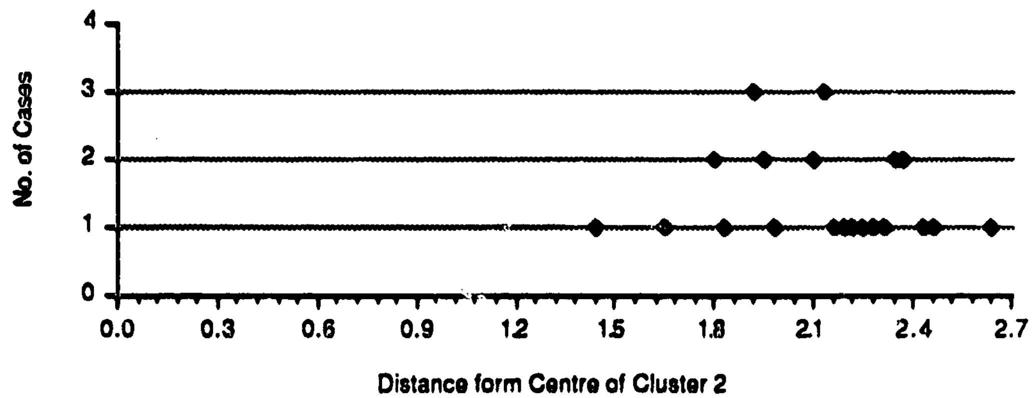


Figure 13. Unskilled Behaviour Characteristics: The distance from the centre of Cluster 2 a) to each case in Cluster 2 and b) to each case in Cluster 1.

The scattergram presented in Figure 14 depicting the orthogonal projection of cases in each cluster, illustrates that the clusters are distinct, but not as clearly separate as was evident with the skilled behaviour characteristics. Cluster means and within-cluster standard deviations are presented in Appendix F.

An analysis of variance of each variable was computed. Table 22 illustrates the ANOVA results for all variables with significant $\underline{F}$-ratios in Cluster 1 and 2.

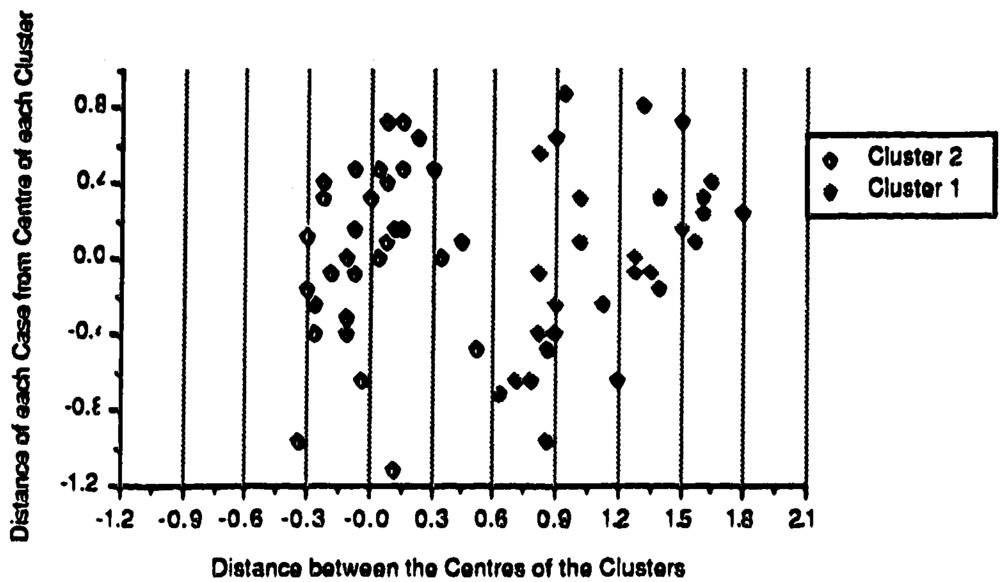


Figure 14. Scattergram showing Cluster 1 and 2 of unskilled behaviours

Table 22

Analysis of Variance for Selected Variables in Cluster 1 and 2

Cluster No. Variable	df Between,Within	MS Between(Within)	F	p
Cluster 1				
Unsure	1,59	14.1820 (.0164)	866.62	.0001
Shy	1,59	1.9121 (.1676)	11.41	.0001
Unmotivated	1,59	1.2405 (.1618)	7.67	.001
Lacks Practice	1,59	.4868 (.1218)	4.00	.024
Cluster 2				
Lacks Rhythm (8)	1,59	.6444 (.1808)	3.56	.035

It is clearly evident from Table 22 that Cluster 1 is largely defined by the variable *unsure*, or the uncertainty experienced by the unskilled in a movement situation. A second, strong defining variable is ***shyness***. Lack of involvement which may be due to shyness may also be attributed to ***lack of motivation***, the third marker of Cluster 1. Either of these characteristics may lead to ***lack of practice***, the fourth significant characteristic. It is clear as was also demonstrated with the clustering of skilled behaviours that there are distinct, affective and metacognitive components to Cluster 1 which relate to difficulties in planning skilled action (***unsure***), and to lack of involvement in physical activity (***shy, unmotivated, lack of practice***). In Cluster 2, on the other hand, lack of rhythm is the single identifying variable. Although there is less obvious strength in Cluster 2, it is interesting to note that ***rhythm*** is also the strongest defining characteristic for those cases in Cluster 1 of the skilled behaviours.

Cluster Assignment and Skill Group Membership

The cluster sizes in the analysis for both skilled and unskilled behaviour characteristics were relatively equal, but there was still a concern that one skill group might be contributing to one cluster more than another. To test this assumption a crosstabulation of cluster membership and skill group membership was carried out for both sets of data. Complete results of the crosstabulation are reported in table form in Appendix F. In the skilled data set there appeared to be a larger number of physical education majors in Cluster 1 and a larger number of expert dancers in Cluster 2, however, Chi-square results, X^2 (3) = 4.89, $p<.0.1798$, were not significant. Similarly, with the unskilled data set, no skill group was represented more than any other in either cluster, X^2 (3) = 2.12, $p<.5470$.

Discussion

The results of the cluster analyses were encouraging. Although this was just a first attempt at classification which cannot be accepted at face value, nevertheless the dominant features of the clusters seemed to reflect the nature of implicit knowledge as it was described by the initial frequency analyses. Although one would expect considerable overlap because of the interactive nature of the components of movement intelligence, there should also be evidence of distinctive knowledge features.

Accordingly, Cluster 1(skilled) was identified by 5 procedural characteristics which tended to emphasize the qualities required for successful execution and precision of movement. Cluster 2(skilled), on the other hand, which comprised 8 variables, was less distinct, in that it was characterized by a combination of affective and metacognitive variables which emphasized social interaction and practice requirements, and the ability and desire to engage in goal directed behaviour. In relation to the knowledge-based model (Wall et al., 1985) then, there is some evidence that implicit knowledge of skilled behaviour can be defined by procedural, affective and metacognitive knowledge components in a fairly clear way.

Although fewer defining variables emerged and more overlap was evident in the clustering of unskilled behaviour characteristics, the relationship to the knowledge bases was still apparent. Cluster 1(unskilled) was largely characterized by a negative metacognitive variable describing the inability to plan appropriate actions. In addition, the importance of affective knowledge was again illustrated. Cluster 2(unskilled) was more weakly defined by the procedural variable, *lacks rhythm.* Although the importance of a procedural knowledge component in unskilled behaviour was underlined, the definition of lack of skill could be described as largely in the metacognitive and affective domains. Since it was possible to identify some dominant characteristics by forming two homogeneous subject groups, it was decided to attempt to further analyze the similarity of the variables by an exploratory factor analysis.

Factor Analysis - Another Approach to Reduction

Although there was some initial hesitance in applying a factor analysis to what appear to be dichotomous variables, coding the data by assigning a one (for presence) and a zero (for absence) does not negate the continuous nature of the characteristics in this study. For example, one does not either have speed or not have speed, but some dimension of this quality. Therefore, the subjects are indicating the relative importance of a variable either by choosing or omitting it and the use of Pearson correlations can be justified. There is also some consensus that factor analysis can be used as an heuristic device for finding general clusterings of variables (Kim & Mueller, 1978). As long as one assumes the conservative stance that a given factor solution is suggestive, that is, it indicates some clustering in the data but also considerable "noise", then the exploration can be a useful exercise.

Factor Analysis Applied to the Skilled Behaviour Characteristics

To this end the DERS Fact20 computer program was applied to the 48 variables describing skill using a varimax rotation. Once an initial solution is entertained, the problem is one of establishing the number of factors to be considered, or where does one stop factoring. One of the common criteria used in making this decision is to retain all factors with an eigenvalue greater than 1. Since this was an exploratory attempt, Fact20 was set to default at all eigenvalues equal to or greater than 1. The result was a 20 factor solution (for eigenvalues see Appendix G). Further elimination of factors was afforded by applying a Scree-test. The rule in this test recommends that after examination of a graph of the eigenvalues, factoring should discontinue at the point where the eigenvalues begin to level off or form an almost horizontal slope (Kim & Mueller (1978). The Scree-test is illustrated in Figure 15.

In examining the graph of eigenvalues it was concluded that not more than four factors should be considered. A varimax rotation was used on the initial solution in an attempt to simplify each column of the factor matrix and to maximize separation of the factors. The four factor solution is presented in Appendix G. Examination of this solution indicated that there were three distinct factors, but that the fourth cross-loaded on Factor 2 and had only two distinct variables. Initial analysis was therefore restricted to a three-factor solution. Table 23 presents the rotated factor matrix for three factors and includes all variables with a positive loading over .3 and ignores all variables with minor loadings. It should be emphasized again that this type of factor-based scale is sought in order to classify the data into a more usable form, and to determine in an heuristic way if the variables have some similarity (Kim & Mueller, 1978).

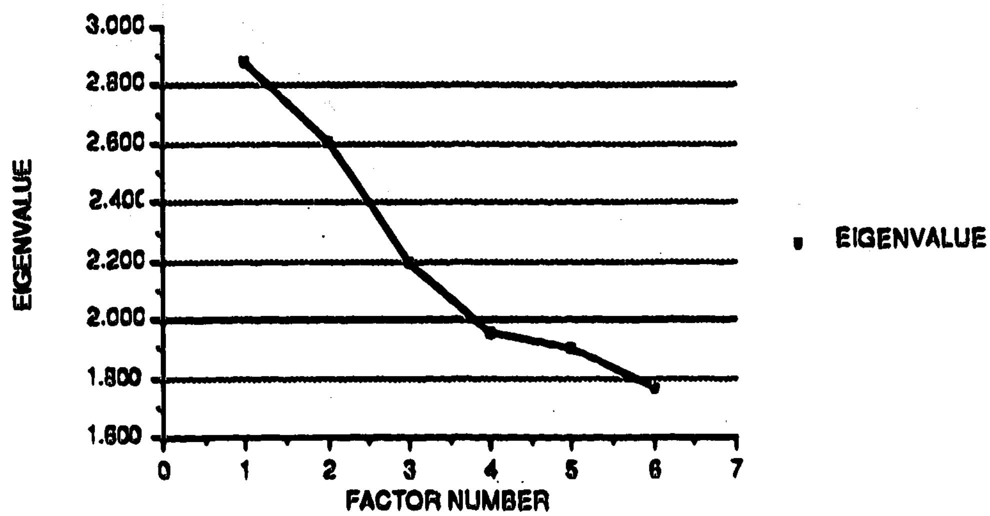


Figure 15. Scree-Test applied to eigenvalues in 6-factor solution of 48 characteristics of skilled behaviour.

There were 10 variables which loaded on Factor 1 with values ranging from :318 to .595. The variables in order of strength were *motivated, intelligent, egotistic, well practiced, deterministic, competitive, mature, perceptive, dedicated,* and *cooperative.* Eight variables loaded on Factor 2, in the following order: *coordinated, stable, agile, strong, fast, graceful, flexible,* and *durable.* It should be noted that *graceful* was the one variable with a high negative loading on Factor 1, but it was retained in Factor 2 because of its definitive procedural characteristics. Four variables loaded on Factor 3 in the following order: *musical, loves dance, expressive,* and *artistic.* Quick perusal of this first factor-based scale would suggest some resemblance to affective, procedural, and domain specific (dance) knowledge components in three factors. It was decided to consider only a two-factor solution for the remainder of the analysis however, since three of the four variable loadings on Factor 3 were small, and their communalities were also below .2. The two-factor solution is presented in Table 24.

Table 23

3-Factor Solution from Varimax Rotation on 48 Skilled Behaviours

Variable Name	Communalities	Factor Loadings 1	2	3
1. Motivated	.439	**.595**	.247	.156
2. Intelligent	.315	**.530**	.166	.080
3. Egotistic	.360	**.483**	-.008	-.164
4. Well Practiced	.242	**.466**	-.109	.113
5. Deterministic	.191	**.404**	-.080	.146
6. Competitive	.171	**.402**	.033	.086
7. Mature	.172	**.384**	-.153	.026
8. Perceptive	.263	**.374**	.257	.239
9. Dedicated	.173	**.323**	-.022	.261
10. Cooperative	.144	**.318**	-.200	-.054
11. Coordinated	.395	-.030	**.621**	.090
12. Stable	.271	-.031	**.503**	-.130
13. Agile	.238	.016	**.484**	.054
14. Strong	.242	.146	**.466**	-.057
15. Fast	.286	.091	**.459**	-.259
16. Graceful	.316	-.365	**.407**	-.132
17. Flexible	.183	-.090	**.406**	.102
18. Durable	.184	.173	**.387**	.070
19. Musical	.347	-.183	-.126	**.545**
20. Loves Dance	.129	-.053	-.082	**.346**
21. Expressive	.138	-.027	.150	**.338**
22. Artistic	.101	.063	-.008	**.312**
Percent Common Variance		36.508	34.418	29.074
Percent Total Variance		5.850	5.515	4.659

In comparison to the 3-factor solution, the results in Table 24 indicate a reduction of one variable in Factor 1, *cooperative*. In addition, seven of the variable loadings on Factor 1 increased somewhat and the ordering of variables was altered so that *well practiced* had the third highest loading and *egotistic* moved down to fifth. *Graceful* had a somewhat higher negative loading on Factor 1.In Factor 2, the five variables with the highest loadings remained in the same order and four of the eight variables had higher loadings. A final attempt to maximize the simple structure was made by running a varimax rotation on only those variables with high loadings or communalities above .2.

Results of the 2-factor solution from the varimax rotation on 17 variables are presented in Appendix G. In general little difference occurred in the ordering of variables on either factor. The loadings on Factor 1, however, increased for every variable, for example, the loading for*motivated* changed from .602 to .630. The variable *egotistic* also replaced *deterministic* as the fourth strongest variable. In Factor 2 the positive loadings increased on every variable except *graceful* which retained a slightly higher negative loading on Factor 1. This increase was substantial for the variable *fast* (.113), which moved from fifth to third in the order.

As was illustrated from the initial 2-factor solution, there were no cross-loadings. Since the factors were reasonably distinct, no further manipulation of the data was considered. Even though these two factors accounted for only 26 percent of the total variance, the outcome of these analyses still provide a suggestion of some clustering in the data which is quite plausible, and a fairly strong suggestion of affective, metacognitive and procedural components to the knowledge base.

Table 24

2-Factor Solution from Varimax Rotation On All 48 Variables Of Skilled Behaviour

Variable Name	Communalities	Factor Loadings 1	2
1. Motivated	.438	**.602**	.277
2. Intelligent	.310	**.524**	.189
3. Well Practiced	.242	**.484**	-.085
4. Deterministic	.189	**.431**	-.056
5. Egotistic	.182	**.427**	-.002
6. Competitive	.170	**.409**	.053
7. Perceptive	.248	**.408**	.285
8. Mature	.168	**.386**	-.137
9. Dedicated	.143	**.378**	.007
10. Graceful	.313	**-.407**	.384
11. Coordinated	.391	-.038	**.624**
12. Stable	.249	-.087	**.491**
13. Agile	.237	.004	**.487**
14. Strong	.228	.104	**.466**
15. Fast	.196	.001	**.443**
16. Flexible	.173	-.082	**.408**
17. Durable	.184	.165	**.396**
Percent Common Variance		51.968	48.032
Percent Total Variance		5.949	5.498

Factor Analysis Applied to the Unskilled Behaviour Characteristics

A similar procedure was followed in applying a factor analysis approach to classification of the unskilled behaviour characteristics. The Fact20 program was used on the 21 variables describing unskilled behaviour which had been generated by 61 subjects. The first pass of the data yielded 9 eigenvalues above 1.0. The eigenvalues for all 21 variables are listed in Appendix H. The Scree-test illustrated in Figure 16 ruled out consideration of all but four factors.

A varimax rotation was applied and examined. Although four factors emerged the solution was not entirely clear. The loadings on the 5 variables in Factor 2 were all below .487 and the variable *lacks practice* loaded on both Factor 2 and 3. In addition, the variable *hesitant* loaded on Factor 1 and 2. The complete solution for four factors is included in Appendix G. In seeking a simpler interpretation, it was decided to consider a 3-factor solution which is illustrated in Table 25. All variables with a positive loading above .3 were included. All minor loadings were disregarded. There were 6 variables that loaded on Factor 1. The positive factor loadings ranged from .664 to .314 and the variables ranked from highest to lowest were: *lacks balance, makes strong moves, lacks control, lacks rhythm, hesitant,* and *uncoordinated.* In addition, *shy* and *unsure* had high negative loading on this factor. Loadings on Factor 2 ranged from .673 to .303. The 6 variables in order were *lacks practice, awkward, hesitant, shy, lacks spatial awareness,* and *unsure.* Factor 3 consisted of four variables with loadings from .671 to .396. The variables -*slow, has poor gait,* and *has poor posture* all had loadings over .6, whereas *imitates others* loaded at .396.

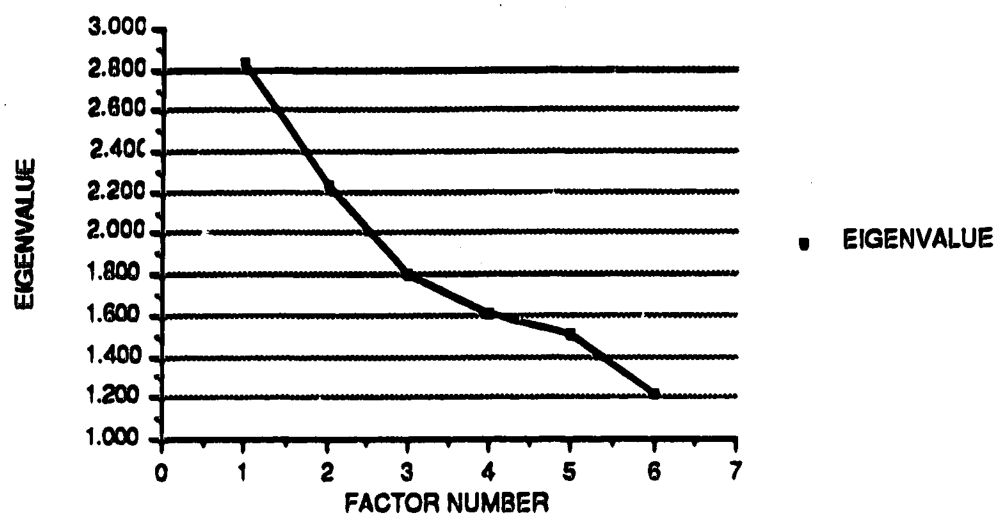


Figure 16. Scree-Test applied to eigenvalues in 6-factor solution of 33 characteristics of unskilled behaviours.

Factor 1 has definite procedural overtones, each descriptor relates to rhythmicity and control of movement in some way. Factor 2, on the other hand, relates to lack of involvement and uncertainty in both action and attitude, a combination of difficulty in the metacognitive and affective knowledge bases. Although these two factors are quite distinct, the positive loading of the variable *hesitant* on both factors stresses the interactive nature of the procedural and metacognitive knowledge bases. Factor 3 is descriptive of problems with gait and initiation of movements and is a clear third factor.

Table 25

3-Factor Solution from Varimax Rotation On 21 Characteristics of Unskilled Behaviour

Variable Name	Communalities	Factor Loadings 1	2	3
1. Lacks Balance	.530	**.664**	.278	.107
2. Makes Strong Moves	.364	**.600**	.010	.061
3. Lacks Control	.342	**.574**	.028	-.108
4. Lacks Rhythm	.333	**.523**	-.203	-.137
5. Hesitant	.371	**.350**	.495	.060
6. Uncoordinated	.117	**.314**	.058	-.123.
7. Lacks Practice	.459	-.035	**.673**	.064
8. Awkward	.343	.116	**.572**	-.046
9. Hesitant	.371	.350	**.495**	.060
10. Shy	.571	-.596	**.439**	-.155
11. Lacks Spatial Awareness.	.179	-.003	**.418**	.059
12. Unsure	.260	-.408	**.303**	-.040
13. Slow	.500	.130	.181	**.671**
14. Has Poor Gait	.396	-.017	-.019	**.629**
15. Has Poor Posture	.483	-.335	.098	**.601**
16. Imitates Others	.262	-.249	-.207	**.396**
Percent Common Variance		39.557	34.077	26.366
Percent Total Variance		12.939	11.146	8.624

It was decided to go to a two-factor solution to see if a clearer interpretation of the second factor would be possible. The solution is provided below in Table 26. As can be seen from the tabled results, the factor loadings remained fairly constant. The variable *uncoordinated* was dropped from Factor

1, and the ordering of all other variables remained the same. *Hesitant* loaded higher on Factor 2, but still at .356 on Factor 1. The loadings of the two strongest variables in Factor 1 increased somewhat, but all other loadings were weakened.

Table 26

2-Factor Solution from Varimax Rotation On 21 Characteristics of Unskilled Behaviour

		Factor Loadings	
Variable Name	Communalities	1	2
1. Lacks Balance	.527	**.672**	.275
2. Makes Strong Moves	.364	**.603**	.009
3. Lacks Control	.316	**.561**	.034
4. Lacks Rhythm	.295	**.507**	-.196
5. Hesitant	.369	**.356**	**.492**
6. Lacks Practice	.450	-.027	**.670**
7. Awkward	.342	.113	**.574**
8. Hesitant	.369	**.356**	**.492**
9. Shy	.565	-.607	**.444**
10. Lacks Spatial Awareness	.173	-.003	**.415**
11. Unsure	.260	-.409	**.304**
Percent Common Variance		53.785	46.216
Percent Total Variance		12.983	11.156

Since the two-factor solution on 21 variables was only slightly simplified, a last attempt to improve it was made by running a varimax rotation on only those variables with high loadings or communalities above .2. The final factor matrix reported here in Table 27 is somewhat easier to interpret, but the crossloading of the variable *hesitant* appears to be a relatively stable construct which cannot be factored out of the data. All variables with loadings over .3 and communalities over .2 are reported.

Table 27

2-Factor Solution from Varimax Rotation On 13 Characteristics of Unskilled Behaviour

		Factor Loadings	
Variable Name	Communalities	1	2
1. Lacks Balance	.529	**.674**	.274
2. Makes Strong Moves	.412	**.634**	.103
3. Lacks Control	.336	**.577**	.048
4. Lacks Rhythm	.350	**.540**	-.243
5. Hesitant	.354	**.406**	**.435**
6. Lacks Practice	.536	.042	**.731**
7. Awkward	.304	.112	**.540**
8. Shy	.633	-.601	**.521**
9. Hesitant	.354	.406	**.435**
10. Unsure	.315	-.388	**.405**
Percent Common Variance		53.489	46.511
Percent Total Variance		19.142	16.645

There are 5 variables loading on each factor, and *hesitant* loads with fairly equal frequency on both. *Lacks spatial awareness* was dropped from Factor 2, and *shy* moved into third place in the order. Factor 2 is largely defined by the first variable, *lacks practice* and tends to relate to avoidance of activity. Both *shy* and *unsure* give definition to the second factor and have high negative loadings on Factor 1. Factor 1 is characterized by difficulties of control and rhythm. Although *hesitant* makes it more difficult to clearly isolate the factors, conceptually it is not difficult to see hesitant movements as both the cause and effect of motor control and confidence problems.

Some valuable information has been gathered while attempting to shed light on the relationship of people's conceptions of movement intelligence to the knowledge bases outlined by the Wall et al. model (1985). There does seem to be a connection between the implicit knowledge of skill generated in this study, the definitions of procedural, affective, and metacognitive knowledge defined by the model, and the necessity of interaction between the separate knowledge bases.

Some Confirmatory Analysis

Some confirmation and comparative analysis of the data reduction procedures which had been used was afforded by deriving factor scores for each subject and comparing the group mean differences. The Ders Fact23 program, which uses the regression method to create factor score estimates, was applied to the factor-based scales derived from both the skilled and unskilled behaviour characteristics. The program output produced two factor scores for each subject which had been estimated by the structure of Factor 1 and Factor 2 on 18 skilled behaviour variables, and 13 unskilled behaviour variables (See Appendix G).

Results of two-tailed *t*-tests on mean Factor 1 scores for Cluster 1 and 2 were highly significant, t (180) = -5.78, p <.0001. Comparison of mean scores on Factor 2 were also significant, t (180) = 5.24, p <.0001. Since Cluster 1 was defined by procedural characteristics and Cluster 2 was defined by affective and metacognitive characteristics, it follows that the Factor 1 scores (of a similar metacognitive nature) should be low for Cluster 1 and high for Cluster 2. The reverse would be expected for Factor 2 mean comparisons. That is, Factor 2 scores should be high for Cluster 1 and low for Cluster 2. Confirmation of these hypotheses helps to lend credibility to the procedural, affective/metacognitive classification which has been proposed.

The same factor scores were used as a basis for comparing skill-group differences. Recall that it was shown earlier that group membership in each cluster was equal. Therefore, we would expect similar mean scores for each group on each factor. A oneway analysis of variance was computed to compare the mean factor scores of each skill group (See Appendix H). Results of the analysis for Factor 1 indicated a small significant main effect, F (3,178) =2.67, p <.0481. Scheffé tests revealed no group differences at p <.05 However a trend was evident as the library users had a slightly higher mean score on Factor 1 than the novices, F (3,178) =3.56, p <.10. A similar comparison done on Factor 2 mean scores yielded no significant differences.

The same procedure was followed in comparing mean factor scores of the two clusters derived from the unskilled behaviour sample. In comparing Factor 1(procedural) mean scores for Cluster 1 and Cluster 2, it was expected that Cluster 1(affective/metacognitive) should have significantly lower mean scores than Cluster 2. A t-test indicated a significant difference between clusters, t (59) =-3.83, p<.0001, as predicted. Similarly, comparison of Factor 2(affective/metacognitive) means for Cluster 1 and Cluster 2, yielded significantly higher scores for Cluster 1 than Cluster 2, t (59) =3.78, p <.0001.

Since the unskilled clusters were also equally represented by all four skill groups, no differences were expected when comparing mean factor scores for each group. In a oneway analysis of variance applied to test this hypothesis, there were no significant group differences when comparing Factor 1 scores. Comparison of Factor 2 scores however yielded a significant effect main effect,

F (3,57) = 7.56, p <.0002. Scheffé tests revealed that the physical education majors scored much higher on Factor 2 (affective/metacognitive) than either the expert or novice dancers, p <.05. No other differences were significant.

Discussion

As an heuristic device to further investigate the relationship of implicit knowledge to the procedural, affective and metacognitive domains, the factoring procedure served its purpose. The two factors which emerged from the skilled behaviour characteristics were distinct in their affective/metacognitive and procedural components. In comparing the variables loading on Factor 1 with the dominant behaviours of Cluster 2, there are four common characteristics, *motivated, intelligent, deterministic* and *well practiced.* The residual variables in Factor 1 tend to emphasize the the need for confidence and problem solving ability, whereas in Cluster 2 the emphasis is on the need for socialization and concentration. Though the specific characteristics vary somewhat, there is clear evidence of strong affective and metacognitive components in both Factor 1 and Cluster 2 which could not be isolated from one another.

Similarly, Factor 2 and Cluster 1 isolated coordination, stability or good balance and agility as common procedural knowledge requirements. In addition, Factor 1 included the characteristics of speed and strength, whereas Cluster 1 emphasized rhythm and good extension. It appears on the surface at least that there is strong agreement as to the specific knowledge domains which characterize skilled behaviour. There is some indication that the clustering technique isolated those procedural characteristics more related to dance, whereas the factoring technique identified those characteristics more related to athletic skill. A third, weaker factor which was initially isolated did identify variables specifically related to expressive qualities of dance. It might be hypothesized therefore that in a confirmatory analysis one might expect the emergence of three factors, one procedural, one metacognitive and one specific to the domain in question.

Results of the factoring procedure of the unskilled variables was not so easily interpreted because of the crossloading of *hesitant* on both Factor 1 and 2. However, there is a more extensive procedural quality to Factor 1 than was evident in Cluster 2. Six distinctly procedural variables including *lacks rhythm* loaded on Factor 1, whereas Cluster 2 was weakly defined by the sole descriptor, *lacks rhythm*.. In contrast, Factor 2 and Cluster 1 had three variables in common, *lacks practice, shy* and *unsure* Factor 2 was strongly identified by the variable *lacks practice*, whereas Cluster 1, it should be recalled was dominated by the variable *unsure*. Although Factor 2 has a decidedly affective and metacognitive flavour, the relatively high loading of the variable *awkward* (.521), and the persistence of *hesitant* gave an additional procedural slant to this factor. It appears that awkward, hesitant movements are just as indicative of low metacognitive knowledge as they are of low procedural knowledge, and that both of these conditions have consequences for negative affect or avoidance of physical activity. It is interesting to note the absence of the variable unmotivated from this factor, since it was a defining characteristic of Cluster 1 and is often mentioned as a consequence of awkwardness.

Some mention should also be made of Factor 3, which was dropped in order to seek a simpler solution. Although Factors 1 and 2 gained some strength in the 2-factor solution, it is debatable whether the analysis is any clearer without Factor 3. The third factor has three strong loadings which relate specifically to slowness of gait and poor posture, and when included the solution can account for 33 percent of the total variance. Further study of a confirmatory nature must be done in order to make this more than speculation.

Even considering the tentative nature of the factoring of unskilled behaviour characteristics, there still seems to be evidence of procedural, affective and metacognitive components to implicit knowledge. Although comparison of the clustering and factoring procedures indicated that the same specific variables may not always be isolated, and the emphasis may vary somewhat, the knowledge components themselves appear to be relatively stable. Since these two procedures yielded such similar solutions, the comparison of mean factor scores of subjects in Cluster 1 and 2 gave some additional support to the theory. Those small differences which were evident when factor scores of each skill group were compared, only served to emphasize the importance of metacognitive knowledge in the production of skilled action. Both library users and physical education majors recognized how the presence or absence of metacognitive knowledge could effect skill level and the development of expertise.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It can be concluded, within the limitations set out at the beginning of this study, that implicit knowledge of skilled behaviour has been effectively demonstrated. As a result of these findings a number of descriptive statements can be made concerning the nature of implicit theories of skill in general, and their relationship to a knowledge-based model of motor skill acquisition, in particular. The implicit theories illustrated in this study closely resemble the documented theories of researchers into the physical skill domain. There seems to be a consensus of what skilled behaviour entails that does not differ too much between theoreticians and lay persons. It is important for researchers to understand what people mean by skill because their implicit theories do in fact serve as the basis of everyday training in parent-child interactions as well as the foundation for informal assessment in daily teaching and coaching situations.

Two aspects of skilled behaviour which may deserve more attention according to implicit views are the ease or grace with which skilled performers can execute specific movements and the social interaction that is both a necessity in acquiring skilled behaviour and a result of having and using it. It is possible that as the demands in a performance environment increase, the continued ease with which a skill is performed may be a valuable discriminator of skill level, but one that is not often measured. The requirement of social interaction may, on the other hand, be a more useful marker of unskilled behaviour, and if promoted could indirectly lead to increased skill development

It can also be said that the implicit views expressed are largely held in common by all four groups questioned. Novice and expert dancers, physical education students and library users all feel that skilled behaviour is characterized by grace, confidence, coordination, and rhythmical movement. In addition, although the agreement is not quite as strong, there is a common understanding of the nature of unskilled behaviour. Unskilled performers are felt to be awkward, unsure and uncoordinated. In contrast, these same groups have very specific conceptions of their own skill level which appear to accurately match the way others perceive them. That is, the experts rank significantly higher in their skill domain and related domains than do novices or the general population. These knowledge differences are worth noting for future research designs because it is often automatically assumed that because experts have better procedural knowledge than their less-skilled peers that they also have better declarative knowledge. At the implicit level, it appears that this may not be the case.

It also appears that the concept of movement intelligence provides a useful vehicle for formulating conceptions of skilled behaviour and that it adequately encompasses the various levels of physical skill that are necessary in everyday, general sport and dance skill environments. Further research will be necessary before it can be concluded that movement intelligence will be adequate in modeling other specific skill domains, but the results do seem promising.

Some interesting conclusions will be entertained with respect to implicit theories and their relationship to a knowledge-based model of motor skill acquisition. Firstly, implicit theories themselves, are evidence of declarative knowledge of skilled behaviour. Secondly, the initial categorization of the data and the additional attempts to further classify the variables give clear support to the representation of skilled behaviour by procedural, affective and metacognitive domains of knowledge. The procedural domain was most effectively isolated. The fairly large number of variables which contributed to this factor make intuitive sense. The complexity of skilled behaviour dictates that no one variable could account for all the requirements. Separation of the affective and metacognitive domains was not possible in this study. Although there was clear evidence of the motivational and goal-oriented requirements of skilled action, there was little support for unique or separate knowledge domains. Since this investigation was done outside of an action context, it cannot be concluded that affective and metacognitive knowledge are not unique in all situations. It may be hypothesized that the level of analysis lacks the specificity to yield such results. A third contention would be that affective and metacognitive knowledge emerge as distinct knowledge domains in response to specific task demands, and tend to interact more often in passive contexts. Further research of a confirmatory nature, with more specific measurement techniques will be needed to clarify these points.

With respect to unskilled behaviour, there is some evidence of representation by the same knowledge structures as shown in skilled behaviour, but the classification techniques each tended to partition one domain more than the other. The procedural domain is clearly demonstrated by factoring and the affective and metacognitive domains are clearly represented by clustering. Unequivocal support for the knowledge-based model with respect to unskilled behaviour must derive from additional study. One interesting aspect of the second factor which evolved from the unskilled data is its close resemblance to the syndrome of physical awkwardness which has been documented by two of the model's authors (Wall, 1982; Wall & Taylor, 1984; Taylor, 1985). Perhaps the attempts to separate these knowledge structures actually deny the necessary interactive nature of awkwardness itself. So just as lack of practice, inability to plan and execute actions, and shyness contribute to awkward behaviour, awkwardness tends to perpetuate and strengthen these component behaviours.

Since it has been demonstrated that a common base of declarative knowledge which is implicit, but not elusive, actually does exist, it now remains to be determined how it can be accounted for by a knowledge-based model. One of the tenets of the model is that metacognitive knowledge about action is a higher level of declarative knowledge that develops as children become consciously aware of their chances of success in everyday action situations (Wall et al., 1985). It is an awareness of all three major categories of knowledge - procedural, declarative and affective. As such declarative knowledge of action is continually modified, used and restructured, it takes on an automatic nature which facilitates functioning in everyday skill learning and performance situations in the absence of conscious control. When the demands of the situation become more taxing, conscious metacognitive strategies will be employed by the more skilled performer in order to meet with success (Wall, 1986).

It is the contention of the writer that the implicit knowledge of skill which has been demonstrated in this study is actually well developed, automatic, metacognitive knowledge. If it were tapped in an action situation it would be distinguished by the term metacognitive skill. Although the model accounts for its development, the efforts made to separate each knowledge base have given the impression that metacognitive knowledge is at the top of the knowledge development hierarchy, and so takes many years to be assimilated. In competitive sport situations requiring high levels of expertise, this contention is probably quite accurate. However, it must be argued that even during the course of development, many of the action situations in which people find themselves require relatively simple, well timed and automatic actions. In order to help depict the interactive, automatic nature of this implicit knowledge base, and still separate it from conscious employment of metacognitive strategies, a simple addition to the original model drawing is suggested.

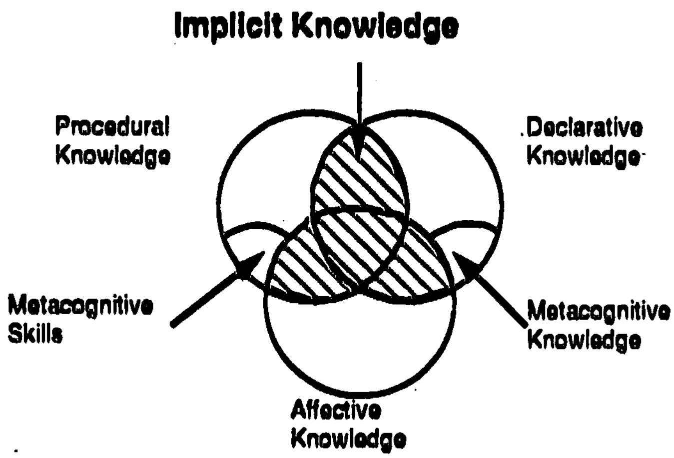


Figure 17. The relation of implicit knowledge to metacognitive knowledge and skills as outlined by the knowledge-based model.

It is hypothesized that the *stuff* described by Lowe (1977), the tacit knowledge depicted by Polanyi (1958), the acquaintance knowledge referred to by Whiting (1980), and the automatic effects of the knowledge base described by Naus and Ornstein (1983), are actually the implicit consequences of metacognitive knowledge. It is shown as the shaded area in Figure 17. In revisiting the processes involved in theory building (Thomas, 1979) then, some confirmation can be given to representation of skilled action by procedural, affective and metacognitive knowledge bases. In addition, it is hypothesized that implicit knowledge is automatized metacognitive knowledge. Lastly, it is suggested that more research leading to redefinition of the interaction of the affective and metacognitive knowledge bases is warranted.

Recommendations

Implicit Knowledge Research

Since this study was just an initial attempt to investigate implicit knowledge in only one specific skill domain, dancing, it would not only seem wise, but imperative, that further research of a similar nature were conducted with an aim to describing additional areas of expertise. There is enough information available from the initial study to conduct a follow-up confirmatory analysis for the dance domain according to Sternberg's research paradigm (1986). This process could be adopted for each area studied until there was a clear indication of the movement related knowledge base in each domain (Reid, 1986). The next step would then involve investigation of the implementation of specific strategic techniques in more traditional experimental fashion.

The conclusions of this study would suggest however that particular care should be taken with the following dimensions of design. It is essential that any groups involved in a knowledge-based study be assessed prior to experimentation to determine the specific nature of their knowledge differences. It is not enough to assume that experts and novices in a particular domain have definable knowledge differences. This assumption must be demonstrated. Therefore, a careful selection of tasks must be conducted so that:

1. specific dimensions of difficulty are documented
2. the problem solving requirements are evident
3. a series of tasks is employed
4. more than one knowledge base is assessed

5. each task is categorized for its importance to the total performance differences.

Metacognitive Assessment

With respect to metacognitive assessment itself, there is a strong need for research into this area in the motor domain. Although there may be some specific differences which necessitate alternative approaches to those which have been taken in the psychological literature, the recommendations of Meichenbaum, Burland, Gruson, and Cameron (1985) should be heeded. That is, it is important to use a multiple-assessment approach in order to illustrate common patterns of metacognition across assessment approaches. For example, there should be congruence between post-performance interview results, concurrent or think-aloud protocols, and performance analyses. With this type of confirmatory analysis it will be possible not only to understand metacognition, but also its interaction with other knowledge bases in the development of skilled action.

A recent study by McPherson and Thomas (in press) has attempted to employ many of the above suggestions in an investigation of the effect of tennis knowledge on decision-making ability during game play. Young novice and expert tennis players were evaluated on tennis knowledge, serve skill and groundstroke before game play. All measures defined the experts as significantly better than the novices. Subsequently, their tennis performance was evaluated for control, decision and execution. The experts performed better in both making decisions and in executing them. The authors used an interesting combination of interviews during and after game play which allowed them to analyze the knowledge structure of the subjects' responses. One of the more interesting results of the study was that experts had a larger repertoire of different action concepts upon which to draw in any situation. In addition, analysis of the interview protocols made it possible to separate metacognitive knowledge (if-then decisions), from metacognitive skill (execution of the skill). Although more of this type of research is definitely needed, it is a step in the right direction.

In summary then, it must be reiterated that this investigation into implicit theories of skilled behaviour has made it possible to identify a common base of declarative knowledge which is implicit, but certainly not elusive. In identifying this knowledge base, support has also been provided for the existence of procedural, affective and metacognitive knowledge domains. Despite the apparent distinctiveness of these three domains, their interactive nature, particularly with respect to affective and metacognitive knowledge, has been underlined. In proposing that implicit knowledge is automatized metacognitive knowledge, further emphasis has been placed on the need for developmental studies which document not only existing levels of knowledge, but also changing levels of knowledge within specific sport and daily movement contexts. The complexity of these issues becomes even more evident when we understand the effects that the level of analysis, the nature of the task under investigation, the demonstrated skill or expertise and the past experience or implicit knowledge of the subjects can have on the conclusions that are drawn. Only when these questions are addressed will our explanations approximate what the human action system actually entails.

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APPENDIX A

SAMPLE OF DATA LISTS

Behaviour Identification List

Behaviours of a Skilled Athlete

001111
____Motivation
____physical ability-good
____competitive
____durability
____must have set priorities, such as training times
____high achiever
____good mental ability as well-can't let the pressures build up
005211
____strong patriotic/team feeling
____deterministic (goal oriented)
____competitive
____cooperation with team
____high ego
009211
____long hours of practice
____detailed study of the nuances of his/her discipline
____careful attention to detail
____listens closely to advice of coaches/fellow athletes/medical advisors
____pays close attention to diet
____follows a fairly strict daily routine
____takes regular rest breaks
013111
____strong
____muscular
____perceptive
____skilled
____flexible
____intelligent
____fast
____coordinated
____has agility
____motivated
____competitive
____mature-could be/immature also
____hard working
____dedicated
____cooperative

Behaviours of Skilled Dancers

078223
_____grace/strength/rhythm
_____balance/fluidness/good vertical
_____coordination
_____smoothness
_____finesse
_____quickness
_____timing
_____endurance
_____control of body
_____skilled planned movements
_____abstract movements
_____confidence in dance (attitude)
079223
_____fluent movement
_____flexible
_____strong powerful movement
_____graceful
080123
_____grace
_____poise
_____aesthetic in movement
_____muscular
_____thin
_____pale
_____petite
_____feminine
_____dedicated
_____artistic
_____unrealistic
_____competitive
_____enthusiastic
081223
_____graceful
_____creative
_____constructive
_____unpredictable
_____forceful
_____elegant movement

Behaviours of a Person Who Moves Well

141234
_____in complete control over his body
_____capable of quality in movement, that would be slow or fast
_____can focus
_____is musical
142134
_____flexibility
_____coordination
_____head up and relaxed
143134
_____smooth gliding rolling motions
_____in time with music
_____feels the music using their moves to express what is in the music
_____or using their moves as an interpretation of the music
_____confident/smiling
_____all movement are executed, it is clear what they are doing (no halfway moves), clear and sharp
____proper body alignment at all times
____energetic
____graceful
144134
_____good posture
_____smooth, fluid movements
_____smile
_____body lifted but not tense
_____coordination
146134
_____good taste in music
_____look like they are having fun, smiling
_____can put on music and start to dance and have a lot of fun
147134
_____erect posture
_____relaxed shoulders
_____curved hands
_____head up
_____neck straight
_____easy walk
_____synchronized arms and legs
_____extended feet

Behaviours of a Person Unskilled in Movement

004141
____hesitancy, not sure of what to do next
____stiffness as in not being relaxed with what they are doing
012141
____clumsy
____not coordinated(eye-hand, eye-foot)
____seems uneasy
____can't pick up a rhythm
____poor balance
____poor control of large and/or small muscles
016141
____clumsy movements
____awkward movements
____tripping over feet
____poor hand-eye coordination
____slow movements
____jerky movements
____unconfident
____hesitant
____tense looking
020241
____quiet, shy
____they usually try and remain self-sufficient and or on occasion are angered if one tries to give assistance
____seem usually in a state of rush
044141
____posture-"shrinking" unconfident body positions, ie bend shoulders inward
____head not held high
____nervous gestures, unconfident apologetic postures
____seem unaware or shocked by environment ie waling into obvious objects like big trees
____hesitant motion ie seeming unsure which direction to go when an obvious direction is evident - taking steps in 3 different directions
____clumsy gestures -knocking things off tables
____awkward movements - perhaps reflect a person who is uncomfortable, self-conscious, unsure of themselves/because of uncoordination.

APPENDIX B

INITIAL MASTER LISTS

Initial List of Skilled Behaviours

1. Motivation
2. Good Physical Ability
3. Competitive
4. Durable
5. Must have set priorities, such as training times
6. Intelligent
7. Cannot let the pressures build up
8. Cooperative
9. Deterministic
10. High ego
11. Hours of practice
12. Detailed study of the nuances of his/her discipline
13. Listens to advice
14. Pays close attention to diet
15. Strong
16. Muscular
17. Perceptive
18. Skilled
19. Flexible
20. Fast
21. Coordinated
22. Agile
23. Mature
24. Immature
25. Dedicated
26. Outgoing
27. Sportsmanlike
28. Aggressive
29. Sense of humour
30. Mesomorph
31. Drink more than most people
32. Women athletes less likely to wear make-up
33. More involved in organized groups
34. Conventional
35. Less tolerant of others
36. Graceful
37. Good concentration
38. Confident
39. Show a natural ability
40. Optimistic
41. Go through the same routine every day
42. Show a type of leadership
43. Proud
44. Fluffy
45. Abstract
46. Peaceful
47. Rhythmical

48. Accurate body positions
49. Performance
50. Posture
51. Pretty/handsome
52. Petite
53. Feminine
54. Eccentric
55. Popular
56. Balance
57. Pale
58. Artistic
59. Creative
60. Good spatial awareness
61. Dynamic
62. Pointed toes
63. Expressive
64. Happy
65. Young
66. Aware of environment
67. Musical
68. Appreciation of music
69. Uses the whole body
70. Long body
71. Self conscious
72. Thoughtful
73. Acne
74. Greasy hair
75. Athletic shoes
76. Dressed casually
77. Has interests related to sport
78. Willing to learn
79. Unsatisfied
80. Always have a knapsack
81. Not interested in academic things
82. Stay around athletic facilities
85. Quick reaction time
86. Frequent participation
87. Personality shines
88. Dumb
89. Usually puts very little effort into simple skills
90. Good communication skills
91. Ability to teach skill
92. Small stature
93. Performs at different levels
94. Not clumsy
95. Can adapt skill or change according to demands of situation
96. Professional
97. Likes performing
98. Love of dance

99. Good observation manner
100. Respect for their bodies and art form
101. Ballet technique
102. Stage presence
103. Point
104. Focus is directed up and out as they dance
105. Spotting and counting especially on new steps
106. Total integration of action
107. Capable of variations in dynamics
108. Can duplicate a choreographer's movement demands
109. Makes the audience fall in love with them
110. Does not drag feet
111. Successful
112. Capability of doing more than one thing at a time
113. At least one free hand
114. Arms are moving
115. Uses each exercise to develop particular body parts
116. Tests his limits as an athlete
117. Willingness to learn
118. Consistency
119. Sexy
120. Tense
121. Insecure
122. Appreciation for styles
123. Desire
124. Open-minded
125. Should be enjoyed
126. Acting ability
127. Delicate

Initial List of Unskilled Behaviours

1. Hesitancy
2. Stiffness
3. Awkward
4. Uncoordinated
5. Effort required
6. Strength of movement
7. Little balance
8. Poor rhythm
9. Anxious
10. Poor control
11. Tripping over feet
12. Poor hand-eye coordination
13. Slow movements
14. Quiet
15. Try to remain self sufficient
16. Angry
17. Usually in a state of rush
18. No direct problem with library usage
19. Poor posture
20. Unaware or shocked by environment
21. Embarrassed
22. Intense
23. Miss completing actions
24. Frustrated
25. Disillusioned
26. Happy at any small success
27. Falling
28. Missing a goal when reaching for something
29. Needs more concentration
30. Lack of practice
31. Determined to overcome lack of dexterity
32. Poor transfer of momentum
33. Poor locomotor skills
34. Poor body management
35. Low self esteem
36. Tremor
37. Extraneous movements
38. Tries to imitate others
39. Get confused easily
40. Poor spatial perception
41. Outcast of group
42. Excuse making to avoid activities
43. Unskilled
44. Exaggerated movements
45. Heavy footed
46. Unimaginative
47. Lacks visual beauty

48. Movements always symmetrical
49. Very controlled
50. Frightened
51. Lack of past support
52. Physical handicaps
53. Aggravation
54. Inferiority
55. Unmotivated
56. Deviant behaviour
57. Inattentive
58. No emotion
59. Sit and watch others
60. Unjured
61. Unfit
62. Not sustained over periods of time
63. Patience with themselves
64. Sensitive to negative feedback
65. Open to corrective feedback
66. No focus
67. Poor gait
68. Giggly
69. Overweight
70. Inflexible
71. Lazy
72. Drag feet when they walk
73. Give up easily
74. Bad attitude
75. Tire out easily
76. Needs steps broken down
77. Dance terminology unfamiliar
78. Difficulty learning new movement
79. Inability to remember and repeat more and 2 movements
80. Is dependent on others for sequencing moves
81. Does not know right and left
82. Reluctant to use arms
83. Feet turn in
84. Over pronounced bow legs
85. Sway back knees
86. Sloped shoulders
87. Walk with too much of a bounce
88. Does not make eye contact
89. Unaware of physical appearance
90. Afraid of person contact
91. Afraid of viewing themself in the mirror while dancing
92. Introvert in class atmosphere

APPENDIX C

EXPANDED MASTER LISTS

CODING INSTRUCTIONS

Expanded Master List of Skilled Behaviours

1. Motivation
2. Physical Ability Good
3. Competitive
4. Durability
5. Must have set priorities, such as training times
6. Good mental ability as well
7. Can not let the pressures build up
8. Cooperation with team - strong patriotic/team feeling
9. Deterministic (goal oriented)
10. High ego
11. Long hours of practice
12. Detailed study of the nuances of his/her discipline
13. Listens closely to advice of coaches/fellow athletes/medical advisors
14. Pays close attention to diet
15. Strong
16. Muscular
17. Perceptive
18. Skilled
19. Flexible
20. Fast
21. Coordinated
22. Has Agility
23. Mature
24. Immature
25. Dedicated
26. Outgoing
27. Sportsmanship
28. Sometimes possess aggressive rather than passive personalities
29. Sense of Humour
30. Mesomorph Build
31. More involved in group activities - willingness/motivation to participate in physical activity (frequent participation)
32. Conventional and conformist (middle-classish)
33. Grace
34. Intense concentration
35. Confidence
36. Shows a natural ability, have an extra edge on other people - making it easier to develop their skills
37. Optimistic
38. Goes through the same routine to get himself ready to play
39. Sometimes seems that they must do fancy tricks or be a little more dramatic, do not mind being watched by groups, actor
40. Pride in talking about his/her skill
41. Abstract
42. Peaceful
43. Rhythmical movement
44. Posture

45. Pretty/handsome
46. Petite
47. Feminine
48. Eccentric
49. Balance
50. Artistic
51. Creative
52. Awareness of body in space, and in movement
53. Dynamic
54. Pointed Toes
55. Facial expressions are readable to the part
56. Happy
57. Usually young
58. Is musical
59. Very long and stretched body, long neckline
60. Thoughtful
61. Athletic Shoes
62. Dressed casual but looks well
63. Willing to learn most other physical skills as long as they do not threaten performance of their primary skills
64. Unsatisfied
65. Stay around athletic places or facilities
66. Quick reaction time
67. Personality
68. Good communication skills
69. Able to change a particular movement if it is not effectively performed
70. A love of dance
71. A definite respect for their bodies and art form
72. Presence - stage presence.

Expanded Master List of Unskilled Behaviours

1. Hesitancy, hesitant movements, brief pauses, not confident in moving
2. Stiffness, inflexible, tense, not fluid, unaesthetic
3. Awkward, clumsy
4. Not coordinated, misses a goal, fumble with objects, looks natural, arms and head uncontrolled
5. Effort required, great expenditure of energy
6. Strength of movement
7. Balance, unstable, shaky
8. Timing, no rhythm, unmusicality
9. Seems uneasy, unconfident, nervous gestures, self conscious, unsure of themselves, embarrassed, anxious, inferiority, fidgety, low self esteem, unsure in attitude, insecure, inhibited, giggly
10. Poor control of large and or small movements, jerky movements, jittery, extraneous movements, choppy, tremor
11. Tripping over feet, stumbling, falling, gait
12. Slow movements
13. Quiet, shy, afraid of person contact, outcast
14. They usually try and remain self-sufficient, sensitive to negative feedback
15. Seem usually in a state of rush, miss completing actions
16. Posture, shrinking unconfident body positions
17. Seem unaware or shocked by environment, bump into objects, easily disoriented, poor spatial perception
18. Intense, happy with small success, very serious, try hard, patient, open to corrective feedback, highly motivated
19. Frustrated, angry, profanity
20. Disillusioned, unwillingness to give more than minimum effort in order to prevent embarrassments, inattentive, no effort, unmotivated, give up easily, bad attitude
21. The person appears to be concentrating on how to perform the next step in the movement, much concentration, very controlled, not automatic
22. Poor transfer of momentum, unskilled, walk with bounce
23. Poor use of body as a whole in order to maximize efficiency, poor body management, lack of body knowledge, does not know difference between right and left, reluctant to use arms
24. Tries to imitate others, watch others, unimaginative
25. Wander aimlessly, get confused
26. Excuse making to avoid activities, do not like class, avoidance, lack of practice
27. Movements always symmetrical, can not concentrate on more than one part at a time, unable to isolate body parts, difficulty learning nvew movement, unfamiliar with dance terminology, difficulty moving in opposition
28. Deviant behaviour
29. Injured
30. Look out of shape, overweight, tire out quickly
31. Movements which are too big, greatly exaggerated
32. Not sustained over periods of time
33. No focus, concentration minimal, does not listen or watch enough

Instructions for Coding of 26% of Data

Your goal is to identify (code) all of the behaviours listed below according to numbers assigned on the master list of skilled behaviours. The behaviours listed represent people's conceptions of athletic skill, dancing skill, and movement skill. The master list comprises all three. You will receive 26% of the entire data list to code.

Procedure:

1. In order to become familiar with the behaviour categories, study the 3 page master list and the 36 page list of coded behaviours. You will notice that a behaviour is given a new number only when it is different from those previously generated.

2. You have 3 practice sheets of behaviours already correctly coded. Practice recoding these behaviours with the aid of the master list, on the blank sheets provided and compare your results to these prepared sheets.. When you have reached 95% accuracy you are ready to start coding.

Determine accuracy by $\frac{\text{number of correct behaviours}}{\text{number of behaviours}} \times 100$

3. Coding-use the master list and code each behaviour with the number that corresponds. Do not create new categories. You must decide to place each behaviour in one of the 72 categories given. Obvious synonyms and root words will be easy to code; some others will require you to decide which category the description is most like.When you see a slash/ that means there is more than one behaviour listed, so code accordingly.

APPENDIX D

FREQUENCY DISTRIBUTION OF 72 SKILLED AND 33 UNSKILLED BEHAVIOUR CHARACTERISTICS

Frequency Distribution for 72 Skilled Behaviour Characteristics

1. Graceful	97	25. Knows Body	16	49. Adapts Skills	5
2. Confident	60	26. Durable	15	50. Has Presence	5
3. Coordinated	59	27. Egotistic	15	51. Abstract	4
4. Erect	44	28. Naturally Skilled	15	52. Pretty	4
5. Flexible	41	29. Optimistic	14	53. Eccentric	4
6. Rhythmical	41	30. Mentally Alert	12	54. Has Long Body	4
7. Dynamic	39	31. Mature	11	55. Wears Gym Shoes	4
8. Strong	37	32. Creative	11	56. Dresses Casually	4
9. Skilled	32	33. Motivated	10	57. Respects Body	4
10. Fit	30	34. Competitive	9	58. Controls Stress	3
11. Deterministic	30	35. Well Practiced	9	59. Sportsmanlike	3
12. Stable	25	36. Participates	9	60. Ritualistic	3
13. Agile	23	37. Cooperative	8	61. Feminine	3
14. Musical	23	38. Aggressive	8	62. Unsatisfied	3
15. Muscular	23	39. Dramatic	8	63. Has Personality	3
16. Dedicated	22	40. Peaceful	3	64. Trains Regularly	2
17. Happy	22	41. Artistic	8	65. Immature	2
18. Knowledgeable	20	42. Receptive	7	66. Has Humour	2
19. Lean	18	43. Loves Dance	7	67. Conforms	2
20. Focused	18	44. Perceptive	6	68. Proud	2
21. Fast	17	45. Well Extended	6	69. Petite	2
22. Outgoing	17	46. Reacts Quickly	6	70. Young	2
23. Expressive	17	47. Communicative	6	71. Thoughtful	2
24. Mesomorphic	16	48. Wants to Learn	5	72. Frequents Gym	2

Frequency Distribution for 33 Unskilled Behaviour Characteristics

1. Awkward	28	17. Has Poor Gait	7
2. Unsure	28	18. Frustrated	7
3. Uncoordinated	23	19. Lacks Practice	7
4. Inflexible	18	20. Intense	5
5. Lacks Rhythm	15	21. Lacks Spatial Awareness	4
6. Shy	15	22. Exaggerates Movement	4
7. Lacks Balance	14	23. Lacks Focus	4
8. Hesitates	13	24. Omits Movements	3
9. Moves Slowly	13	25. Unskilled	3
10. Lacks Control	11	26. Confused	3
11. Unmotivated	11	27. Unfit	3
12. Has Poor Body Image	11	28. Requires Effort	2
13. Has Poor Posture	10	29. Makes Strong Moves	2
14. Lacks Automaticity	10	30. Sensitive	2
15. Imitates Others	8	31. Deviant	2
16. Unable to Isolate	8	32. Injured	2
		33. Cannot Sustain Movement	2

APPENDIX E

TWO-WAY ANOVA TABLES FOR SELF RATINGS

Analysis of Variance For Group Self Ratings on Movement Skill
By Skill Group and Question Asked

Source	df	MS	F	p
Question	3	4.558	2.93	.035
Skill Group	3	33.299	21.37	.0001
Group x Question	9	1.473	.945	.486
Error	227	1.558		

Analysis of Variance For Group Self Ratings On Dance Skill
By Group and Question Asked

Source	df	MS	F	p
Question	3	4.177	1.54	.206
Skill Group	3	45.014	16.57	.0001
Group x Question	6	2.316	.852	.569
Error	227	2.717		

Analysis of Variance for Group Self Ratings on Athletic Skill
By Skill Group and Question Asked

Source	df	MS	F	p
Question	3	2.851	1.53	.208
Skill Group	3	101.663	18.15	.0001
Group x Question	9	2.487	1.33	.221
Error	227	1.867		

APPENDIX F

MEAN DISTANCES AND
STANDARD DEVIATIONS FOR EACH VARIABLE IN EACH CLUSTER

CROSSTABULATIONS FOR CHI SQUARE ANALYSIS
OF GROUP MEMBERSHIP IN EACH CLUSTER

Mean Distance of Each Variable
From the Centre of Cluster 1

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
.0206	.1753	.0412	.0825	.0309	.0309
.0515	.0515	.1340	.0515	.0928	.0206
.0928	.2474	.1134	.0206	.2165	.2577
.1237	.3918	.1856	.0928	.0515	.0515
.1546	.0928	1.000	.0515	.3505	.0412
.0515	.0515	.3093	.2990	.2062	.0515
.0825	.0928	.1959	.0619	.1031	.1134
.0515	.0309	.0103	.0206	.0825	.0309

Mean Distance of Each Variable From the Centre of Cluster 2

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
.0941	.1529	.0588	.0824	.1059	.1059
.1059	.1059	.2353	.1176	.1294	.0588
.1059	.1529	.1294	.0471	.1294	.1882
.0588	.2471	.0588	.1529	.1647	.0353
.1059	.0824	.0	.1529	.3059	.1294
.1059	.0353	.1294	.2118	.0588	.0353
.0353	.1059	.2353	.0	.0824	.1412
.0588	.0353	.0824	.0471	.0588	.0471

Standard Deviation of Distance of Each Variable From the Centre of Cluster 1

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
.1428	.3822	.1999	.2765	.1740	.1740
.2223	.2223	.3424	.2223	.2916	.1428
.2916	.4338	.3187	.1428	.4140	.4397
.3310	.4907	.3908	.2916	.2223	.2223
.3634	.2916	.0	.2223	.4796	.1999
.2223	.2223	.4646	.4602	.4067	.2223
.2765	.2916	.3989	.2421	.3057	.3187
.2223	.1740	.1015	.1428	.2765	.1740

Standard Deviation of Distance of Each Variable
From the Centre of Cluster 2

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
.2937	.3621	.2367	.2765	.3095	.3095
.3095	.3095	.4267	.3241	.3376	.2367
.3095	.3621	.3376	.2130	.3376	.3932
.2367	.4339	.2367	.3621	.3731	.1856
.3095	.2765	.0	.3621	.4635	.3376
.3095	.1856	.3376	.4110	.2367	.1856
.1856	.3095	.4267	.0	.2765	.3503
.2367	.1856	.2765	.2130	.2367	.2130

Mean Distance of Each Variable
From the Centre of Cluster 1(Unskilled)

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21			
.2069	.2414	.5517	.4138	.2069	.0345
.1724	.1379	.9655	.1724	.1379	.2069
.4483	.2414	.1034	.1724	.3793	.2069
.1724	.2414	.1034			

Mean Distance of Each Variable
From the Centre of Cluster 2(Unskilled)

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21			
.2187	.3437	.3750	.4375	.2812	.1562
.2812	.3437	.0	.1875	.1562	.2187
.0937	.0937	.0937	.0625	.0937	.1562
.0937	.0625	.1562			

Standard Deviation of Distance of Each Variable
From the Centre of Cluster 1 (Unskilled)

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21			
.4123	.4355	.5061	.5012	.4123	.1857
.3844	.3509	.1857	.3844	.3509	.4123
.5061	.4355	.3099	.3844	.4938	.4123
.3844	.4355	.3099			

Standard Deviation of Distance of Each Variable
From the Centre of Cluster 2 (Unskilled)

Variable Number					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21			
.4200	.4826	.4919	.5040	.4568	.3689
.4568	.4826	.0	.3966	.3689	.4200
.2961	.2961	.2961	.2459	.2961	.3689
.2961	.2459	.3689			

Crosstabulation of Group Membership in Cluster 1 and 2 (Skilled)

Count Expected Value Row Percent Column Percent			Row Total
Group	1	2	
1	26 24.0 57.8% 26.8%	19 21.0 42.2% 22.4%	45 24.7%
2	29 25.0 61.7% 29.9%	18 22.0 38.3% 21.2%	47 25.8%
3	24 24.0 53.3% 24.7%	21 21.0 46.7% 24.7%	45 24.7%
4	18 24.0 40.0% 18.6%	27 21.0 60.0% 31.8%	45 24.7%
Column Total	97 53.3%	85 46.7%	182 100%

Crosstabulation of Group Membership in Cluster 1 and 2 (Unskilled)

Group	Count Expected Value Row Percent Column Percent 1	2	Row Total
1	7 7.1 46.7% 24.1%	8 7.9 53.3% 25.0%	15 24.6%
2	10 7.6 62.5% 34.5%	6 8.4 37.5% 18.8%	16 26.2%
3	6 7.1 40.0% 20.7%	9 7.9 60.0% 28.1%	15 24.6%
4	6 7.1 40.0% 20.7%	9 7.9 60.0% 28.1%	15 24.6%
Column Total	29 47.5%	32 52.5%	61 100%

APPENDIX G

ORDERED EIGENVALUES FOR SKILLED AND UNSKILLED VARIABLES

4-FACTOR VARIMAX ROTATION ON 48 SKILLED VARIABLES

2-FACTOR VARIMAX ROTATION ON 17 SKILLED VARIABLES

4-FACTOR VARIMAX ROTATION ON 21 UNSKILLED VARIABLES

ANOVA TABLES FOR GROUP SCORES ON FACTORS 1 AND 2 (SKILLED AND UNSKILLED)

Ordered Eigenvalues* for 20 Factors of Skilled Behaviour

Variable					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20				
2.888	2.606	2.197	1.958	1.899	1.765
1.624	1.618	1.526	1.510	1.440	1.340
1.302	1.265	1.216	1.157	1.141	1.093
1.067	1.005				

* Criterion = above 1.00

Ordered Eigenvalues* for 9 Factors of Unskilled Behaviour

Variable					
1	2	3	4	5	6
7	8	9			
2.829	2.240	1.800	1.07	1.513	1.215
1.166	1.057	1.016			

* Criterion = above 1.00

4-Factor Solution from Varimax Rotation on 48 Variables Of Skilled Behaviour

Variable Name	Communalities	Factor Loadings 1	2	3	4
1. Motivated	.460	**.568**	0.287	0.170	-.162
2. Intelligent	.329	**.50**	0.204	0.097	-.170
3. Well Practiced	.245	**.491**	-.055	-.009	0.015
4. Deterministic	.202	**.441**	-.027	-.006	0.084
5. Egotistic	.261	**.427**	0.038	-.154	-.233
6. Mature	.174	**.397**	-.107	-.065	-.024
7. Competitive	.184	**.393**	0.061	0.100	-.125
8. Dedicated	.214	**.391**	0.033	0.033	0.243
9. Perceptive	.267	**.380**	0.284	0.204	0.001
10. Cooperative	.157	**.327**	-.152	-.164	-.005
11. Coordinated	.422	-.061	**.629**	0.018	0.149
12. Stable	.295	-.099	**.512**	-.154	0.015
13. Agile	.266	-.010	**.499**	-.028	0.127
14. Fast	.308	-.006	**.480**	-.263	-.094
15. Strong	.248	0.071	**.467**	0.029	-.153
16. Durable	.185	0.142	**.401**	0.061	-.011
17. Flexible	.185	-.104	**.397**	0.093	0.089
18. Graceful	.334	-.438	**.350**	0.059	-.127
19. Skilled	.330	-.100	**.310**	-.147	**0.451**
20. Musical	.418	-.066	-.174	**.591**	0.183
21. Expressive	.254	0.002	0.107	**.489**	-.052
22. Rhythmical	.284	-.324	0.134	**.392**	0.086
23. Artistic	.163	0.109	-.029	**.387**	-.008
24. Happy	.239	-.125	-.236	**.367**	-.180
25. Skilled	.330	-.100	0.310	-.147	**.451**
26. Natural Skill	.192	0.065	-.066	-.127	**.409**
27. Dramatic	.199	-.145	-.023	-.124	**.403**
28. Loves Dance	.175	0.055	-.063	0.123	**.39[illegible]**
Percent Common Variance		29.614	27.146	21.85	21.384
Percent Total Variance		5.953	5.457	4.394	4.299

2-Factor Solution from Varimax Rotation on 17 Variables Of Skilled Behaviour

Variable Name	Communalities	Factor Loadings	
		1	2
1. Motivated	.453	**.630**	.237
2. Intelligent	.332	**.551**	.170
3. Well Practiced	.262	**.505**	-.088
4. Egotistic	.214	**.462**	-.019
5. Deterministic	.222	**.460**	-.102
6. Competitive	.208	**.454**	-.045
7. Perceptive	.260	**.425**	.281
8. Mature	.180	**.397**	-.164
9. Dedicated	.150	**.387**	-.150
10. Coordinated	.413	-.065	**.640**
11. Stable	.334	-.113	**.567**
12. Fast	.309	.014	**.556**
13. Agile	.270	-.001	**.520**
14. Strong	.243	.138	**.473**
15. Flexible	.178	-.064	**.417**
16. Durable	.198	.163	**.414**
17. Graceful	.303	-.409	**.368**
Percent Common Variance		52.214	47.783
Percent Total Variance		13.556	12.405

4-Factor Solution from Varimax Rotation on 21 Variables Of Unskilled Behaviour

Variable Name	Communalities	Factor Loadings 1	2	3	4
1. Lacks Balance	.593	**.733**	0.100	0.194	0.094
2. Strong Moves	.389	**.618**	-.075	-.007	0.044
3. Lacks Control	.349	**.575**	-.012	-.054	-.122
4. Lacks Rhythm	.333	**.478**	-.15	-.235	-.155
5. Hesitant	.388	**.376**	0.487	0.067	0.071
6. Uncoordinated	.118	**.315**	0.040	-.019	-.129
7. Hesitant	.388	0.376	**.487**	0.067	0.071
8. Awkward	.343	0.184	**.480**	0.279	-.031
9. Lacks Spat. Aw	.208	0.015	**.442**	0.079	0.077
10. Frustrated	.392	-.279	**.409**	-.133	-.359
11. Lacks Practice	.574	0.120	**.384**	0.638	0.077
12. Lacks Practice	.574	0.120	0.384	**.638**	0.077
13. Shy	.663	-.467	0.211	**.618**	-.135
14. Unsure	.423	-.278	0.038	**.586**	-.032
15. Slow	.544	0.121	0.239	-.109	**.679**
16. Poor Gait	.396	-.006	-.036	-.014	**.628**
17. Poor Posture	.484	-.308	0.077	0.099	**.612**
18. Imitates Others	.262	-.261	-.185	-.062	**.395**
Percent Common Variance		30.870	25.132	22.703	21.295
Percent Total Variance		12.460	10.144	9.163	8.595

Oneway Analysis of Variance of Group Scores on Factor 1(Skilled)

Source	df	MS	F	p
Between Groups	3	2.6269	2.69	.0481
Within Groups	178	.9782		

Oneway Analysis of Variance of Group Scores on Factor 2(Skilled)

Source	df	MS	F	p
Between Groups	3	1.8026	1.82	.1454
Within Groups	178	.9912		

Oneway Analysis of Variance of Group Scores on Factor 1(Unskilled)

Source	df	MS	F	p
Between Groups	3	1.3601	1.36	.2639
Within Groups	57	.9994		

Oneway Analysis of Variance of Groups Scores on Factor 2(Unskilled)

Source	df	MS	F	p
Between Groups	3	5.7807	7.55	.0002
Within Groups	57	.7653		